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Rio Blanco Oil Shale Company

MODULAR DEVELOPMENT PHASE MONITORING REPORT TWO

VOLUME 1 OF 2

DECEMBER 1977 THRU MAY 1978 MID-YEAR REPORT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)
A General Partnership
9725 East Hampden Avenue, Denver, Colorado 80231

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RIO BLANCO OIL SHALE COMPANY
MODULAR DEVELOPMENT PHASE
MONITORING REPORT 2

December 1977 - May 1978
MID-YEAR REPORT

SUBMITTED TO
RIO BLANCO OIL SHALE COMPANY
DENVER, COLORADO

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SECTION 1
INTRODUCTION

In 1969, the U.S. Department of the Interior initiated planning for a prototype oil shale leasing program that eventually resulted in Gulf Oil Corporation and Standard Oil Company (Indiana) acquiring an oil shale lease for Tract C-a in the Piceance Creek basin of northwest Colorado. These two companies are now operating the tract under a general partnership called the Rio Blanco Oil Shale Company (RBOSC).

Since its inception in 1974, the RBOSC has been conducting extensive environmental data collection programs. Between October 1974 and September 1976, two years of baseline data were gathered. From September 1976 through August 1977, interim environmental data were collected during the period in which RBOSC had suspended most tract development activities. In August 1977, RBOSC launched their Modular Development Phase (MDP) Environmental Monitoring Program. The first report of MDP environmental activities (September -November 1977) was published in February 1977. The current report represents RBOSC's second MDP Monitoring Report, and covers the period from December 1977 - May 1978.

The RBOSC MDP Environmental Monitoring Program is designed to collect air quality, meteorology, terrestrial ecology, aquatic ecology, and hydrology data. Monitoring program designs are based on analysis of baseline and interim studies data, an assessment of probable developmental impacts, and recommendations from the Area Oil Shale Office (AOSO). The current monitoring program is being conducted according to the RBOSC Modular Development Phase Environmental Monitoring Program Scope of Work dated March 17, 1978. This scope of work reflects the environmental monitoring philosophy set forth in RBOSC's Detailed Development Plan (DDP).

NUS Corporation is the lead environmental contractor, responsible for air quality, meteorology, terrestrial ecology, and aquatic ecology studies. Hydrology studies are being conducted by Wright Water Engineers, International Engineering Co., and the United States Geological Survey (USGS). Dames and Moore collects the joint basin-wide visibility data, and Morrison-Knudsen collects the noise data.

Data collected during MDP monitoring studies are reported semi-annually, in a mid-year and a year-end report. Monitoring Report 2, the first mid-year data report, presents the data collected for the six-month period, a summary of the winter and spring data, brief discussions of the data, comparisons of the winter and spring 1978 data with previous winter-spring data where applicable, and notations on impacts caused by initial development activities, if any.

Objectives of the monitoring program methods are presented only if they differ from the objectives presented in RBOSC MDP Monitoring Report 1, or if clarification was required. Volume 1 of this report contains six sections as follows:

Section 1 - Introduction
Section 2 - Atmospheric Studies
Section 3 - Terrestrial Studies
Section 4 - Aquatic Studies
Section 5 - Hydrology Studies
Section 6 - Summary

Volume 2 contains the following data appendices:

2-1 Air Quality Data
2-2 Meteorological Data
3-2 Vegetation Data
3-3 Fauna Data
4-1 Physical Data
4-2 Water Quality Data
4-3 Periphyton Data
4-4 Macroinvertebrate Data
5-1 Hydrology Well Data
5-2 Surface Water Data
5-3 Ground Water Data
5-4 Erosion Data

SECTION 2

ATMOSPHERIC STUDIES

The Tract C-a atmospheric studies program consists of two elements - (1) measurements of total suspended particulate matter and certain chemical compounds, and (2) measurements of selected meteorological parameters. The monitoring locations were originally established to measure the ambient air quality generally upwind and somewhat removed from the expected tract development, and at points where tract developments might have an effect on the air quality. Simultaneous meteorological measurements were made to allow evaluations of air quality changes and for prediction of the dispersion of emissions from tract development.

Air quality and meteorological data have been obtained from monitoring instruments located on or near Tract C-a since February 1975. The first two years of data collection make up the baseline data set. Data from the baseline period were obtained at four locations around the tract. Following the baseline period, an interim data acquisition program was established to cover an interval during which the tract development lease conditions were modified and partially suspended. During the interim period (February through August, 1977), a single air quality and meteorological monitoring station was operated to maintain data continuity.

The current program is part of the Modular Development Phase (MDP). The level of activity on the tract, principally construction work, has increased significantly during the MDP period. The monitoring program has also been increased in order to measure possible effects on the ambient air quality. Two of the sites that had been deactivated for the interim period were refitted with meteorological instrumentation and put back online during the MDP first quarter. In addition, one of the reactivated meteorological sites is gradually being refitted with a set of air quality instrumentation. This will be completed by June 1979.

2.1 AIR QUALITY

National Ambient Air Quality Standards (NAAQS) have been adopted to ensure safe concentrations of certain pollutants in the ambient air. Air quality monitoring has been conducted on and near Tract C-a to establish the existing level of these pollutants before and during tract development. Tract development activities are expected to result in the emission of certain gases into the ambient air that have the potential for adversely affecting air quality.

An ambient air monitoring network (Figure 2-1a) was established for measuring gaseous pollutants at the outset of the MDP monitoring period. Site 1 is located just west of the tract boundary. A second air quality monitoring station, identified as Site 3, was operated during the first quarter of the MDP program. Both sites were operated during baseline. The location of this site is just east of the tract boundary. In contrast to Site 1, which generally measures background ambient air quality conditions, Site 3 is located in a broad gulch that may experience some air quality changes due to down-valley dispersion from the main development in the center of the tract. The monitoring instruments at each site are housed in an environmentally controlled shelter and draw a sample of the ambient air from a common glass manifold which has an intake 4 m above the ground. Each monitoring instrument is connected to a strip chart recorder which continuously records the instrument output signal. In addition, an automatic data acquisition system scans each parameter being measured once every three minutes and computes a running 15-minute average. The current average value is recorded on magnetic tape at the end of each quarter hour. Hourly averages are automatically computed from the 15-minute averages when the data are reduced. The hourly average value of a parameter is centered on the hour (i.e., the data point computed at 0200 hours is the average that was obtained between 0130 and 0230). Data taken during second and third quarters of the MDP program are presented in Appendix 2-1.1 and discussed in the following pages.

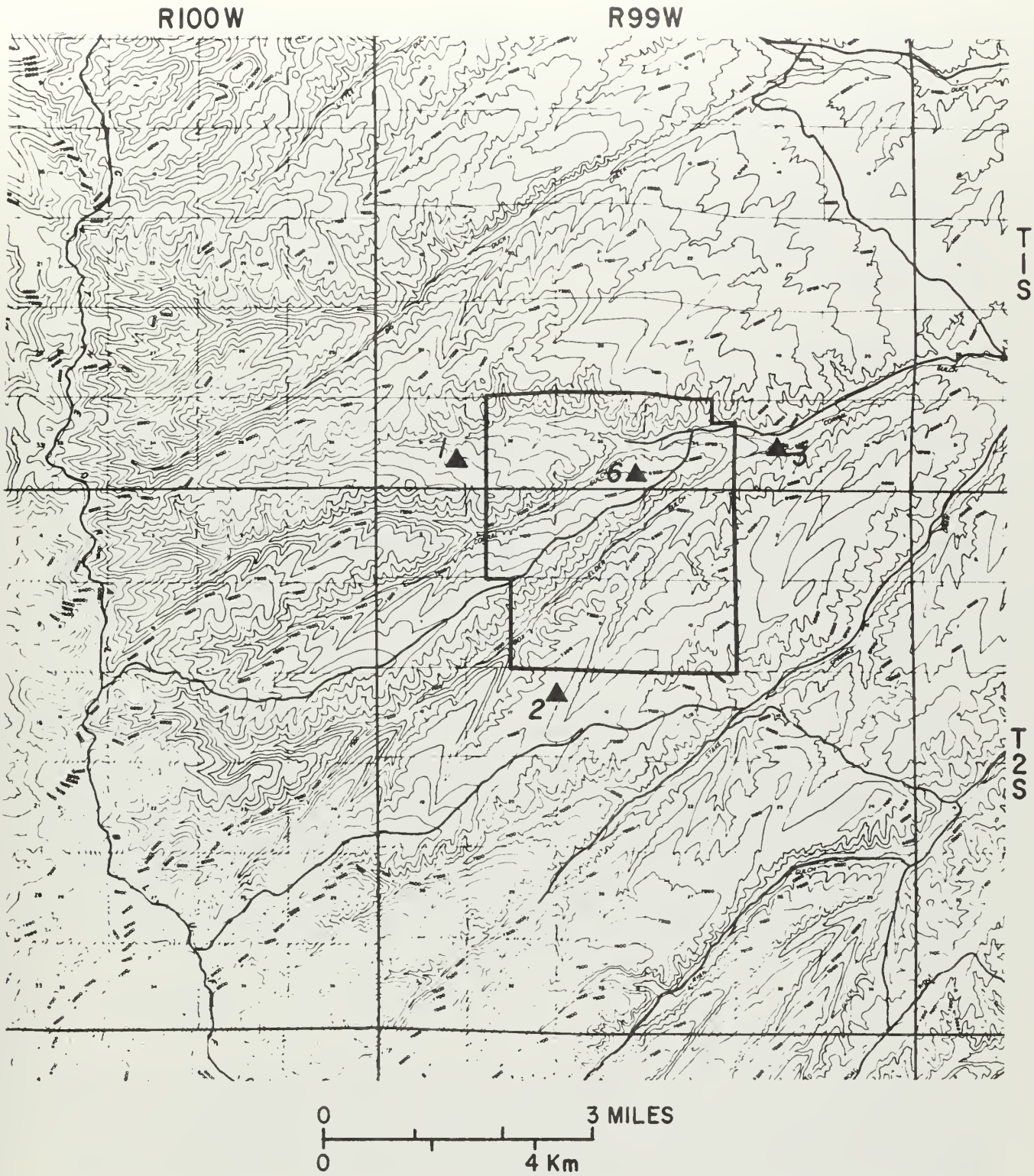


Figure 2-1a. Locations of ambient air quality network for the MDP monitoring program.

A. Sulfur Dioxide

Sulfur dioxide is produced principally by the combusion of sulfur-bearing fossil fuels. At the present time the amount of combusion that takes place in the tract region is very low and it is to be expected that there would be little sulfur dioxide in the ambient air. However, with further tract development some fuel combusion will be required and sulfur dioxide emissions may increase.

1. Objectives

The objective of monitoring for sulfur dioxide is to establish the ambient air concentration prior to and during tract development. The existing sulfur dioxide levels and their associated environmental effects can be compared to future environmental changes that may be related to any increase in the concentration of sulfur dioxide.

2. Methods

Sulfur dioxide monitoring is conducted with an automated chromatograph that analyzes a sample of ambient air every three minutes. The instrument has a threshold of detection of approximately 20 parts per billion of sulfur dioxide. This parameter is currently being measured at two sites; the instrument at Site 1 has been in continuous operation since the baseline study, while the instrument at Site 3 was reactivated during the second quarter of the MDP (January 1978).

3. Results and Discussion

The continuous measurements provided concentration readings that were below the reliable threshold of detection for most of the period. There were a few periods when low concentrations of sulfur dioxide were measured

by the instrument at Site 1. However, the hourly concentrations never exceeded 0.04 ppm, far below the 0.5 ppm 3-hour sulfur dioxide secondary standard. A detailed review of the data, instruments, and associated meteorological conditions lead to the conclusion that the upscale values were probably due to temporary offsets in the instrument. However, since this could not be conclusively proven, the data were not deleted.

B. Hydrogen Sulfide

Hydrogen sulfide in the ambient air is generally the result of emissions from the decay of sulfur-containing organic materials, release from underground oil, gas or water deposits, or emissions as a result of volcanic action. Some low concentrations of hydrogen sulfide might be recorded due to surface pumping of underground water on the tract during the MDP period. There are no air quality standards for ambient air concentrations of hydrogen sulfide in the tract area. However, the gas is toxic, and at low concentrations represents a nuisance because of its odor.

1. Objectives

The objective of monitoring hydrogen sulfide in the ambient air on the tract is to establish the background value. Tract development which will involve recovery of sulfur-bearing organics may release hydrogen sulfide into the ambient air. Concentrations of this constituent in the future may be compared to pre-development conditions to assess environmental impacts.

2. Methods

Hydrogen sulfide is currently being measured at Sites 1 and 3 by the same gas chromatographs that detect sulfur dioxide. The instruments have a reliable threshold of detection for hydrogen sulfide of 20 parts per billion.

3. Results and Discussion

The concentration of hydrogen sulfide in the tract area was below the threshold of detection of the instrumentation for most of the data period. Low upscale concentrations (never exceeding 0.04 ppm) were recorded infrequently at Site 1, but never at Site 3 (comparable to the sulfur dioxide results). These upscale concentrations are suspect for two reasons: the pollutant should be noticed also at Site 3, and both SO_2 and H_2S (usually produced by different sources) tended to track one another. However, as with the sulfur dioxide data, the hydrogen sulfide data could not conclusively be labelled as incorrect.

The average concentration of both sulfur dioxide and hydrogen sulfide during this six-month period is less than the reliable threshold of detection. This is consistent with the average concentrations found during the baseline and interim data periods.

C. Nitrogen Oxides

Nitrogen oxides (NO_x) generally are produced by high temperature combustion which fixes atmospheric nitrogen. Nitric oxide (NO) is produced chiefly by internal combustion engines. In the tract area there are only small amounts of automotive exhaust or combustion that would result in the generation of nitrogen oxides, and it is to be expected that no significant concentration of these constituents would be found.

1. Objectives

Nitrogen oxides are monitored to establish the existing natural background levels prior to major tract development and operation. Tract operations will involve substantial combustion with the generation of nitrogen oxides. Nitric oxide in the presence of sunlight and hydrocarbons may be a mechanism for smog production. These data may prove useful in correlating future visibility changes with pollutant concentration.

2. Methods

Nitrogen oxides are measured at Site 1 by instrumentation that detects the chemiluminescent reaction between nitric oxide and ozone. Nitric oxide is detected directly, and the other oxides of nitrogen, principally nitrogen dioxide, are catalytically converted to nitric oxide for detection. The instrument provides data values for both nitrogen oxides and nitric oxide. The difference between the two is assumed to be nitrogen dioxide. The reliable threshold of detection of the instrumentation is 10 parts per billion nitrogen dioxide.

3. Results and Discussion

During the monitoring period the concentrations of nitrogen oxide over a few-hour period were slightly greater than the reliable instrument threshold. The highest hourly average concentrations for nitrogen oxides and nitric oxide were 23 and 9 parts per billion, respectively. These were probably not instrumentation anomalies, because the ozone data show a concurrent decrease every time upscale NO_X was the conversion from NO by the rapid reaction between NO and ambient ozone. (This is the same reaction that is used in the gas phase titration to calibrate the ozone analyzer.) The source of the NO is not clear. Although automotive sources are possible, there is some doubt that this was true in this case due to the location of the sampler and occurrences of high levels in the middle of the night.

Despite these excursions, the average concentration of both NO_X and NO during this six-month period is less than the instrument threshold. This is consistent with the average concentrations found during the baseline and interim data periods.

D. Carbon Monoxide

Carbon monoxide results from the incomplete oxidation of carbon during conbustion.

1. Objectives

Carbon monoxide is monitored to establish the ambient air concentration of this constituent prior to and during tract development activities. Vehicular use and fuel combustion during tract development may result in the emission of carbon monoxide in the tract area.

2. Methods

Carbon monoxide in the ambient air is monitored at Site 1 by an instrument which uses the infra-red radiation-absorbing properties of this constituent. The reliable threshold of detection of the instrument is one part per million.

3. Results and Discussion

No measurements of carbon monoxide were reported above the reliable threshold of the instrument. Much of the time the output of the instrument was above the threshold, but this was due to the detector, which produces a mean output signal with predominantly positive noise in the absence of a sample. This was confirmed by comparing the weekly zero checks with the ambient readings of the instrument. In all cases, there was no significant difference between the instrument zero and the ambient measurement. Consequently, no carbon monoxide values above the threshold of the instrument are reported in the data set.

E. Hydrocarbons

Hydrocarbons in the ambient air may originate from a variety of sources:

- Natural methane
- Evaporated solvents and volatile liquids
- Unburned fractions of organic fuels
- Vegetation

A national ambient air quality guideline for the concentration of non-methane hydrocarbons in the ambient air has been established for use in planning air pollution abatement programs where non-methane hydrocarbons are precursors for photochemical smog.

1. Objectives

Methane and total hydrocarbon monitoring has been conducted to determine the concentration of these constituents in the ambient air prior to and during major tract development activities.

2. Methods

Methane and total hydrocarbon monitoring is conducted at Site 1 with a gas chromatograph instrument that detects constituents with a flame ionization device that measures the carbon content of the sample. The instrument is only specific for methane. The reliable threshold of detection for methane and total hydrocarbon is 20 parts per billion. The non-methane hydrocarbon concentration can be obtained by subtracting the methane value from the total hydrocarbon value, but the uncertainty in each of these parameters is such that the potential exists for considerable error in the difference value.

3. Results and Discussion

The methane/hydrocarbon analyzer apparently began to fail in the middle of October 1977. This is evident from an inspection of the raw data set, which shows steadily declining methane and total hydrocarbon values through the beginning of December. The data produced by the analyzer was stable from December 1977 through February 1978, but the average methane and the average total hydrocarbon concentrations were 0.6 and 0.8 ppm lower than the pre-October readings, respectively. Detailed analysis of the method by which the instrument measures this pollutant indicated that the

partial failure was due to wear and ozone-induced ageing on a set of critical "O" rings. Gas leakage past the "O" rings allowed dilution of the air sample with hydrocarbon-free air. In early March 1978, the "O" rings were replaced and the methane/hydrocarbon data immediately increased, indicating that the abnormally low values recorded by the system between October 1977 and March 1978 were due to improper instrument function, which could not be detected until the data were analyzed and compared.

Replacement of the "O" rings in the methane/hydrocarbon analyzer produced methane values in March 1978 that were 10 percent (0.15 ppm) higher than in September 1977. The data collected during the period of increasing component failure were corrected back to values expected under normal analyzer operation experienced in September and early October 1977. The corrected methane data may be as much as 10 percent low, since the methane values in September 1977 and March 1978 do not agree to closer tolerances.

Replacement of the "O" rings in the methane/hydrocarbon analyzer in March 1978 produced total hydrocarbon data that were 25 percent (0.6 ppm) higher than in September 1977. However, experience with the data has shown that the total hydrocarbon concentrations vary more than the methane concentrations, thus, part of the discrepancy between the "before" and "after" periods may be real data variation. The total hydrocarbon data, like the methane data, were corrected back to values expected on the basis of operation in September and October 1977. It is possible, then, that the total hydrocarbon data as reported may be as much as 25 percent low.

The corrected methane concentrations varied from 1.28 to 1.60 ppm during the reporting period. The corrected total hydrocarbon concentrations during the same time period varied from 2.00 to 2.60 ppm. The source of the non-methane hydrocarbons has not yet been identified. Guidelines for non-methane hydrocarbon concentrations have been published by EPA but no standard has been promulgated at this time.

Because of the uncertainty in non-methane hydrocarbon measurements, the Area Oil Shale Supervisor has waived the requirement for reporting the hydrocarbon data after February 7, 1978, until the state of the are is improved.

F. Ozone

Ozone concentration is taken as a measure of total oxidants in the ambient air. In urban areas ozone is thought to be the result of the interaction of nitrogen oxides and sunlight in a complex photochemical reaction initiated by automobile exhaust emissions. A national ambient air quality standard has been established for the concentration of total oxidants in the ambient air. Ozone is a powerful oxidizer and can damage vegetation and materials as well as produce deleterious health effects in man and animals.

1. Objectives

Ozone monitoring is conducted to establish the ambient air concentration of this constituent prior to and during tract development and operation. The potential emission of nitrogen oxides coupled with hydrocarbons and strong sunlight may produce photochemical reactions in the future in the tract area.

2. Methods

Ozone is detected in a sample of the ambient air by reacting the sample with ethylene gas to cause a chemiluminescent gas phase reaction between the ozone and the ethylene. The method is specific for ozone and has a threshold of detection of 10 parts per billion.

3. Results and Discussion

Ozone data were recorded for the entire six-month period at Site 1 and Site 3. The range of ozone concentrations was 0.032 to 0.088 ppm at Site 1 and 0.005 to 0.072 ppm at Site 3. The current primary hourly NAAQS of 0.08 ppm was exceeded 29 times during the period at Site 1. There were no violations of the proposed new primary standard of 0.10 ppm.

The 29 violations are reasonably consistent with the five violations recorded during the two baseline years and the one violation recorded during the first quarter of the MDP period. It contrasts strongly with the interim monitoring period, which had a large number of violations. At this time, there is no obvious reason for the high number of violations during the interim period; approximately 94 percent of the observations above the standard were in the 0.08 - 0.10 ppm range.

A very strong diurnal variation with a daytime maximum occurred at Site 3. A much weaker diurnal cycle was found at Site 1. This pattern is similar to that found in the baseline studies. During the first three quarters of the MDP program, Site 3 always had lower ozone concentrations than Site 1 - usually the Site 3 concentration would be slightly lower during the day and much lower at night. However, it was noted in the baseline study that the average ozone concentration at Site 3 was higher during the day than at Site 1. Due to frequent internal span checks and quarterly calibrations, the pattern found during the MDP program is considered valid. A more detailed analysis of the ozone data and possible sources will be prepared for the year-end report.

G. Particulates

Though the National Ambient Air Quality Standard for total suspended particulate matter (TSP) does not differentiate among sources of the pollutant, recent regulations to accomplish the prevention of significant deterioration (PSD) of air quality distinguish between "fugitive dust" and other particulate matter. "Fugitive dust" is defined as particulates of native soil uncontaminated by the pollutants which result from industrial activity. Fugitive dust may originate at haul roads or exposed surfaces though the action of man or the wind or both. Fugitive dust is excluded from current PSD regulations.

1. Objectives

The objective of atmospheric particulate monitoring is to establish the

natural background concentration and the effects of construction in the modular development phase of tract operations.

2. Methods

The total suspended particulate load in the ambient air is determined by the federal reference method utilizing high volume sampling. During the monitoring period total suspended particulate measurements were made every sixth day until late March, when the frequency was increased to once every fourth day and all sites were placed on the same date schedule. There are four sites where particulate data are taken: Sites 1 and 2, which are generally upwind of the construction area; Site 3, which may be exposed to particulates generated on the tract access roadway (about 200 yards away) or to particulates generated at the construction area under certain valley flow conditions; and Site 6, which is adjacent to the main construction area.

3. Results and Discussion

Table 2-1 presents the geometric mean and highest concentrations of total suspended particulate matter measured at the four sites during the monitoring period. The days with the highest concentrations occurred on days with high winds. Generally, higher values occurred simultaneously at all stations.

Three total particulate concentrations in excess of the federal primary 24-hour TSP standard of 260 $\mu g/m^3$ were measured during the reporting period at Site 6. One additional measurement at Site 6 was in excess of the federal secondary standard of 150 $\mu g/m^3$. No other elevated readings were gathered at any other site (Appendix 1-1.2). The four incidents of elevated TSP concentrations collected at Site 6 reflect the presence of particulates caused by construction activities near the monitor, and largely represent windblown fugitive dust in the atmosphere.

Table 2-1. Geometric Mean and Maximum of Suspended Particulates ($\mu g/m^3$) December 1977 - May 1978

	Site 1	Site 2	Site 3	Site 6
Second Quarter MDP				
Geometric Mean	3.6	2.9	5.4	14.1
Maximum	8.5	4.7	32.6	27.5
Third Quarter MDP				
Geometric Mean	11.5	10.9	16.6	63.7
Maximum	38.0	39.1	62.9	1,220

2.2 METEOROLOGY

Meteorological parameters are monitored to provide information on the general climate of the tract area and to provide a basis for estimating the potential impact of emissions that will result from tract development and operation. Three sites have been in operation since the first quarter of the MDP. Sites 1 and 2 are both at higher elevations just west and southwest of the tract boundary, respectively, and Site 3 is located just east of the tract boundary in a broad gulch.

Data from Site 1 are presented in Appendix 2-2.1, and data from Sites 2 and 3 are presented in Appendix 2-2.2.

A. Wind and Air Temperature

1. Objectives

The stability of the atmosphere, as measured by the temperature differential within the lowest layers of the atmosphere, has a profound effect on the dispersion of emissions into the atmosphere that may occur as a result of tract development and operation. The wind speed and direction also influence atmospheric dispersion. Measurement of the frequency of occurrence of wind speed and wind direction classes can be used in interpreting air quality data.

2. Methods

Wind speed and direction are measured by instruments at the 10-m and 60-m levels at Site 1, and at the 10-m level at Sites 2 and 3. Air temperature is measured at the 10-m level at all three sites. Temperature differential between the 10- and 60-m levels is measured at Site 1.

3. Results and Discussion

Westerly winds prevailed at Sites 1 and 2 during the period. At Site 3, there was a strong tendency for the wind to be oriented along the axis of the gulch (southwest or northeast).

B. Precipitation

1. Objective

Precipitation is recorded to provide data on the scavenging effects of rain and snowfall on air quality. The moisture content of the ground surface may also influence wind erosion.

2. Methods

Precipitation is monitored at all three sites with several gauges. At Sites 1 and 2 there is a tipping bucket gauge, a heated total precipitation (weighing bucket) gauge, and a manually operated wedge gauge. At Site 3, there is a tipping bucket gauge and a wedge gauge. The two automatic gauges at sites 1 and 2 provide results which do not always agree closely even though they are located about 20 feet apart. It is suspected that there is some influence due to the location of the shelter that partially shields one or both of the automatic gauges from snowfall and from the wind flow that accompanies most shower-type rainfall. The wedge gauges were installed to provide data at a location removed from the influence of the instrument shelter.

3. Results and Discussion

Precipitation data from the several measuring methods are included in the data appendix (Appendix 2-2.3). There is a significant difference in the

reported precipitation between the gauges installed at each site but good agreement among sites for a particular gauge type. Although the wedge gauges generally have better exposure, the weighing bucket gauges have better collection and retention efficiency and are therefore considered more accurate. The weighing bucket gauges at Site 1 and 2 recorded 8.5 and 8.0 inches of precipitation, respectively, during the six month data period. These are considered the most representative precipitation data at the site.

C. Other Meteorological Parameters

Insolation and relative humidity are measured routinely at Site 1.

1. Objective

Insolation is monitored to acquire a data base useful in interpreting air quality data. Relative humidity data can be used in evaluating potential cooling system alternatives.

2. Methods

Insolation is measured with a pyranometer mounted at ground level. Relative humidity is measured with a sensor utilizing a hygroscopic plastic film that is mounted at the 30-m level on the Site 1 tower.

3. Results and Discussion

The majority of the days during the monitoring period were clear with high insolation values, typical of a high elevation site with a dry climate. The relative humidity varied from a low of 16 percent to a high of 74 percent. The data from this reporting period are comparable to the data reported from the biennial baseline period.

Plans are currently being made to augment the relative humidity data with instrumentation designed to measure dewpoint. Data available from this instrument will provide additional information for interpreting the air quality data.

D. Visibility

Documentation of visibility in the Piceance Creek Basin is a cooperative study conducted by the Rio Blanco Oil Shale Company and the C-b Shale Oil Venture.

1. Objectives

The objectives of this program are to document the visibility in the area of the Piceance Creek Basin and identify trends or variations in visibility which may be evident during the monitoring program. The results of this program will provide visibility data against which past and future data may be compared and with which concurrent meteorological and air quality data may be incorporated for further evaluation and consideration.

2. Methods

The methods employed in the documentation of basin-wide visibility during this study incorporated techniques identical to those utilized during the baseline study conducted during 1975 - 1976, and described in RBOSC MDP Monitoring Report 1, and will not be discussed in detail in this report. Data are collected every sixth day during the two seasons: the Spring, represented by April and May, and the Fall, represented by October and November, from a centrally located shelter (Figure 2-1). Visibility measurements presented in this report were obtained during the Spring Quarter, 1978. Approximately 280 measurements were obtained during this period.

PICEANCE CREEK BASIN VISIBILITY STUDY
CAMERA SITE AND VIEWS
1975 - 1976

VIEW:	I		II		III		IV			
OBJECT:	0	1	2	3	4	5	6	7	6	9
DISTANCE: (MILES)	29	54	24	42	10	37	17	26	46	56

SCALE: 0 5 10 15 MILES

ALLRED PEAK
LITTLE SNAKE R
RIVER
YAMPA
VIEW I
WAPITI PEAK
VIEW II
DANFORTH HILLS
MOFFAT COUNTY
ROUTT COUNTY
RIO BLANCO COUNTY
WHITE RIVER
YELLOW CREEK
VIEW III
MEEKER
NORTH FORK WHITE RIVER
CATHEDRAL BLUFFS
TRACT C-a
BLACK SULPHUR CREEK
PICEANCE CREEK
TRACT C-b
VIEW IV
CAMERA
HUNTER CREEK
GARFIELD COUNTY

Figure 2-1. Locations of Basin-wide Visibility Study.

3. Results and Discussion

During the Spring 1978 monitoring period, visual range measurements were made during 10 scheduled days of photography over a two-month period. Of a possible 280 measurements, 272 were obtained for a 97 percent data recovery. There were no days during which no measurements were obtained. Detailed information on the method of data presentation and data collected for the period are presented in Appendix 2-2.4.

Daily mean visual ranges during the Spring Quarter exhibited large fluctuations; variations in the mean visual range of consecutive days of photography ranged from less than two miles to more than 40 miles. The largest of these occurred between May 6 and May 12, 1978 when the mean visual range increased from 50 to 94 miles. The 6th of May was characterized by scattered snow showers, May 12th by clear skies.

The daily mean visual ranges obtained every 6th day during the Spring Quarter are listed in Table 2-2. Mean visual ranges generally occurred in the mid-sixties to the lower nineties, although daily mean visual ranges near 50 miles were recorded. The hourly visual ranges used to compute the daily mean are included in Appendix 2-2.4.

Daily mean visual ranges during this period were slightly higher than those recorded during the Spring Quarter of 1976, although extreme values were similar. During 1976, the maximum and minimum daily mean visual ranges recorded were 101 and 45 miles, respectively; during 1978 the respective values were 102 and 50 miles.

Fluctuations in the mean visual ranges, although large, were generally similar among the views. An increase or decrease in the mean visual range for an individual view was generally matched by a similar response in the remaining views. These fluctuations, shown in Figure 2-2, illustrate the continuity in the response of the views to changing visibility restrictions.

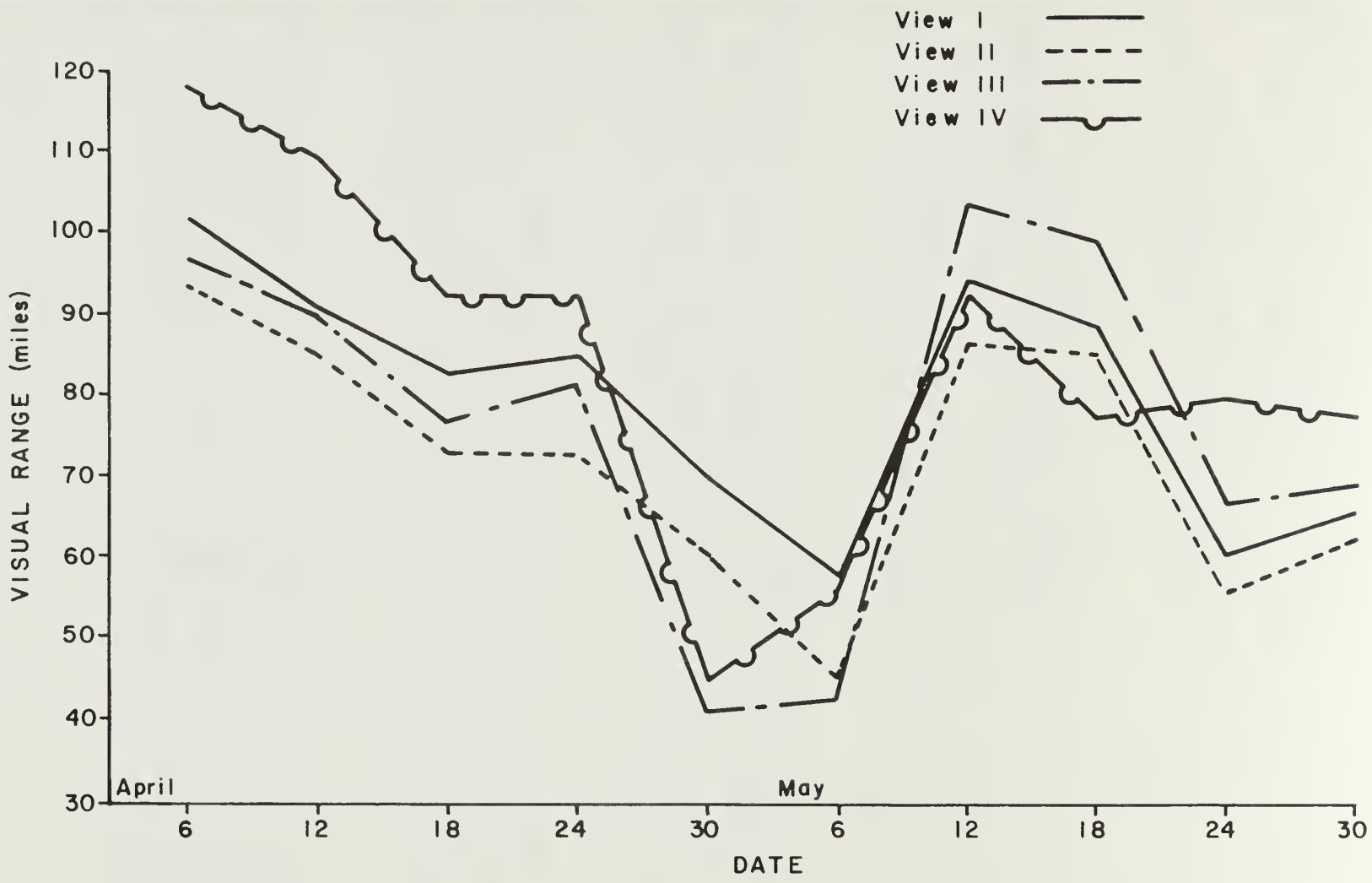


FIGURE 2-2

VARIATION IN DAILY MEAN VISUAL RANGE FOR EACH VIEW
PICEANCE CREEK BASIN, COLORADO
SPRING, 1978

Table 2-2. Daily Mean Visual Range (miles), Piceance Creek Basin, Colorado, Spring, 1978.

Date	Mean Visual Range
April 6, 1978	102
April 12, 1978	94
April 18, 1978	81
April 24, 1978	83
April 30, 1978	54
May 6, 1978	50
May 12, 1978	94
May 18, 1978	88
May 24, 1978	66
May 30, 1978	69

Days of low mean visual ranges, such as April 30 and May 6, were characterized by passing rain or snow showers which restricted visibility during some periods. No instance of severe restrictions to visibility which interrupted the photographic measurements was reported, however occurrences of haze which affected the clarity of the objects being photographed were reported. Haze in Views I and II, for example, was often reported during the morning hours and, on occasion, was reported as lasting all day.

Days of high mean visual ranges, such as April 6 and 12 had little or no haze. The mean visual ranges for these days were 102 and 94 miles, respectively. A copy of the Site Log is included as Appendix 2-2.4.

Monthly mean visual ranges were considerably higher in April 1978 than in April 1976, although the May values for both years were within four miles. The mean visual range for April 1978 was 83 miles, compared with 67 miles during 1976. The mean visual range for May 1976 was 70 miles; for May 1978, it was 74 miles. The general characteristics for April and May 1978 are listed in Table 2-3.

The monthly composite distribution of visual range, shown in Figure 2-3 illustrates the high frequency of high values during April. Visual ranges during April and May, however, exhibited a similarity in the range of values obtained. The minima were within four miles; the maxima were within 20 miles.

During the Spring Quarter, visual ranges were generally high. Ninety-five percent of the visual range measurements were greater than 43 miles, 50 percent were greater than 71 miles. This compares with 39 and 67 miles during 1976, respectively. Pertinent statistics for each view and all views combined during the Spring Quarter are listed in Table 2-4.

The mean visual ranges of the four views during the Spring Quarter were comparable. The mean visual range in View II was the lowest. The mean visual ranges for Views I, III, and IV were 81, 77, and 84 miles, respectively. The mean visual range in View II was 73 miles. The distribution of visual range in the four views is shown in Figure 2-4.

Table 2-3. Visual Range (miles) Statistics for all Views Combined for each Month of Monitoring, Piceance Creek Basin, Colorado, Spring 1978.

Month	Mean	Maximum	Minimum	Standard Deviation
April	83	142	21	21.1
May	74	132	17	20.5

Table 2-4. Visual Range Summary (miles), Piceance Creek Basin, Colorado, Spring, 1978.

View	Mean	Maximum	Minimum	Fifth[1] Percentile	Standard Deviation
I	81	126	51	53	16.5
II	73	112	32	42	17.1
III	77	132	17	35	23.7
IV	84	142	35	45	24.8
Composite	79	142	17	43	21.2

[1]That value above which fall 95% of the measurements

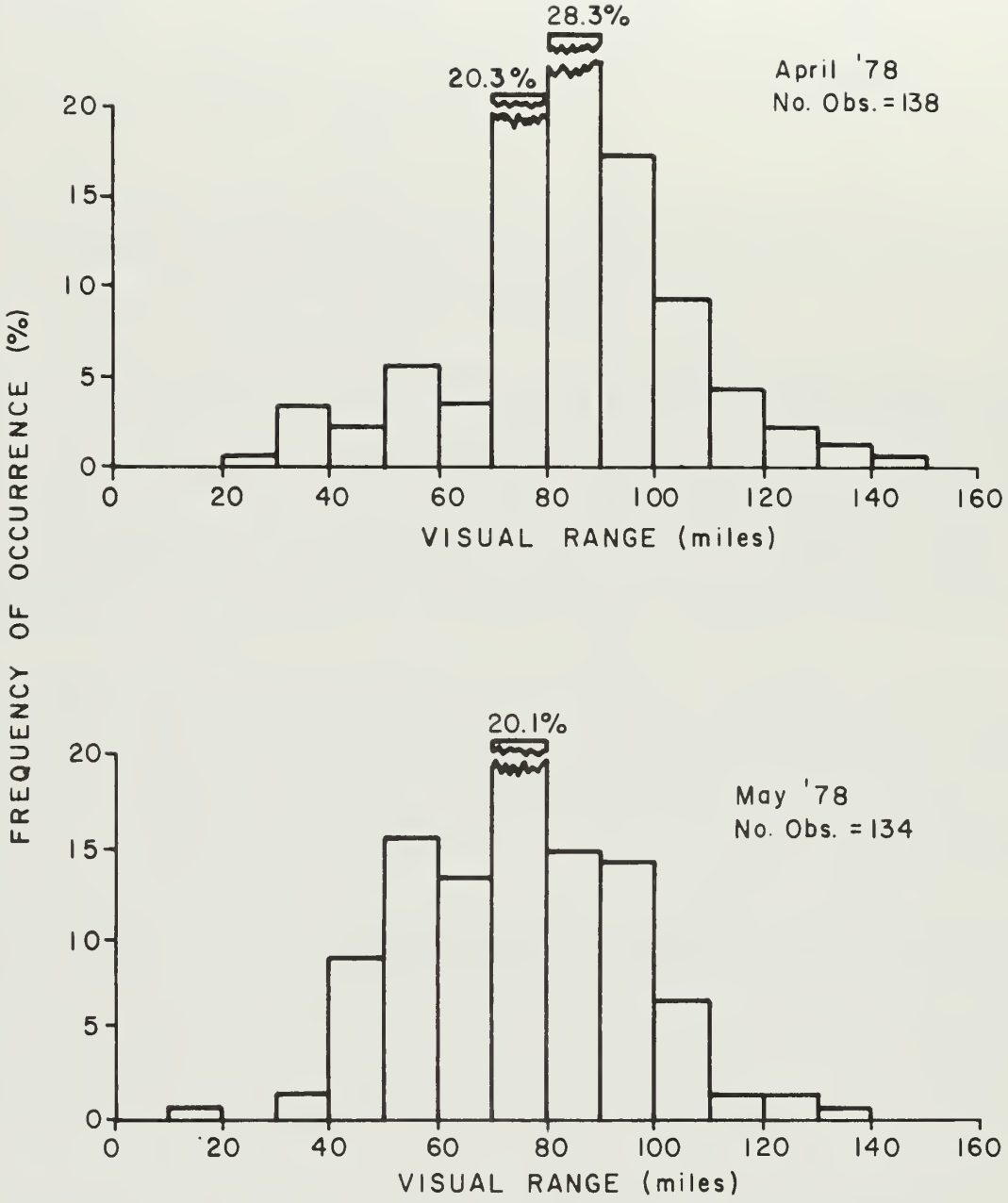


FIGURE 2-3

MONTHLY COMPOSITE DISTRIBUTION OF VISUAL RANGE
PICEANCE CREEK BASIN, COLORADO
SPRING, 1978

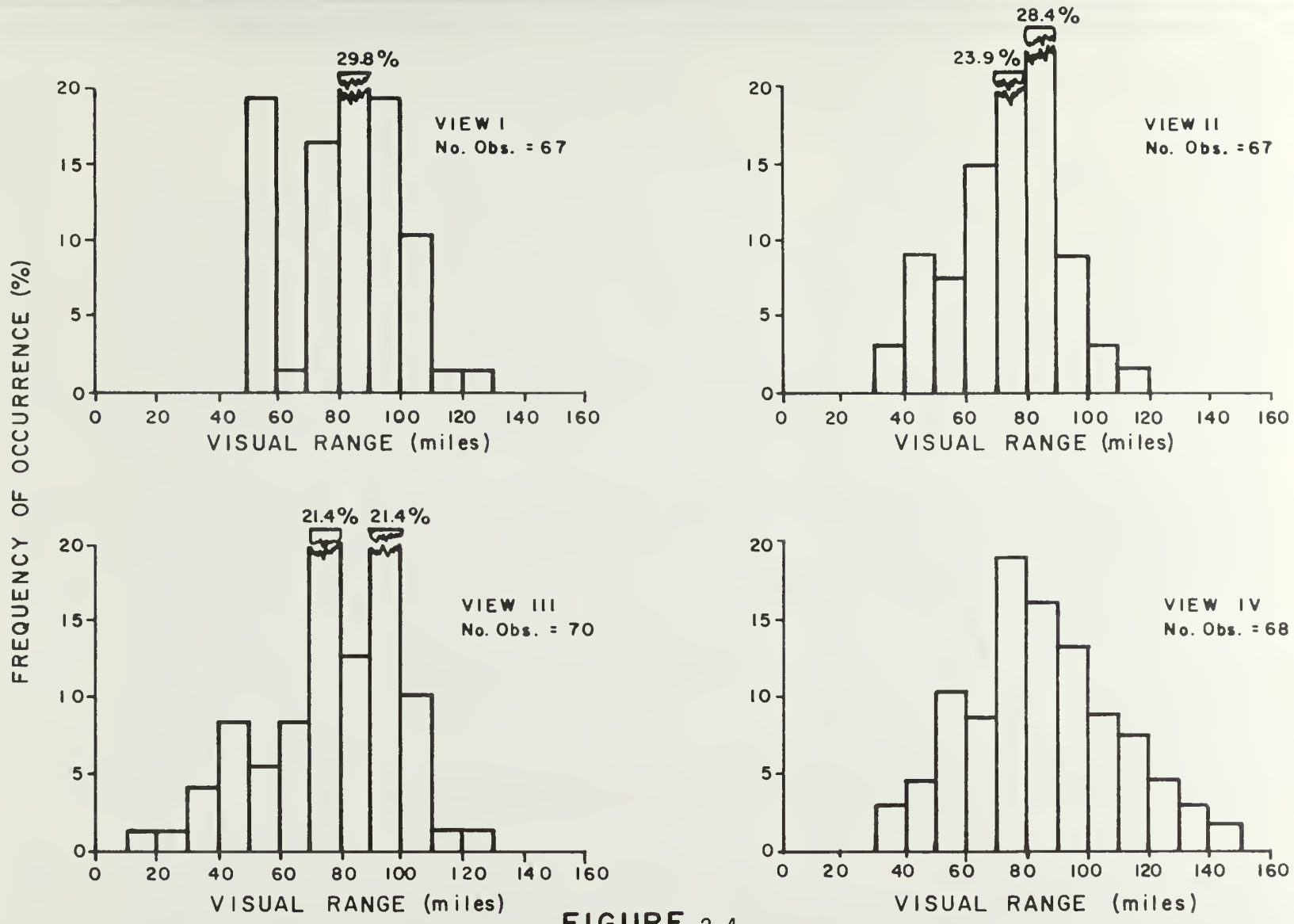


FIGURE 2-4

DISTRIBUTION OF VISUAL RANGE IN EACH VIEW
PICEANCE CREEK BASIN, COLORADO
SPRING, 1978

E. Noise

Development activities on Tract C-a will result in increased noise levels in the area. In order to assess the potential effects of these increased noise levels, it will be necessary to identify the sources of the noise and the intensity of noise levels at various distances from these sources. The RBOSC environmental noise survey is designed to provide these data.

1. Objectives

RBOSC will conduct periodic noise surveys on the tract to (1) determine ambient noise levels, (2) determine noise levels when equipment is operating, (3) identify spatial decreases in noise levels, and (4) determine the net increase in noise levels on tract as a result of development activities.

2. Methods

In order to acquire the necessary noise level measurements, sound level readings are made once each quarter at strategic locations around the site development area. During the period of study, two series of noise measurements were taken. Series I, taken on January 25, 1978, consisted of noise measurements from 13 locations in a spiral-like configuration at various distances from the mine site area (Figure 2-5). Series II, taken on March 17, 1978 included noise measurements from 15 locations proximal to the shaft (Figure 2-6).

Sound level readings are taken with a Bruel and Kjaer Sound Level Meter,Type 2205.The accurate range of this instrument is 20 to 130 dB. A Condenser Type 1, ANSI S1.12 omnidirectional microphone is used to receive noise impulses. The sound level meter is calibrated with a Bruel and Kjaer Sound Level Calibrator,Type 4230 operating on a frequency of 1000 Hz $\pm$ 1%. Wind speed is determined with a Taylor Instrument Company, handheld anemometer. Wind direction is estimated with the aid of a compass.

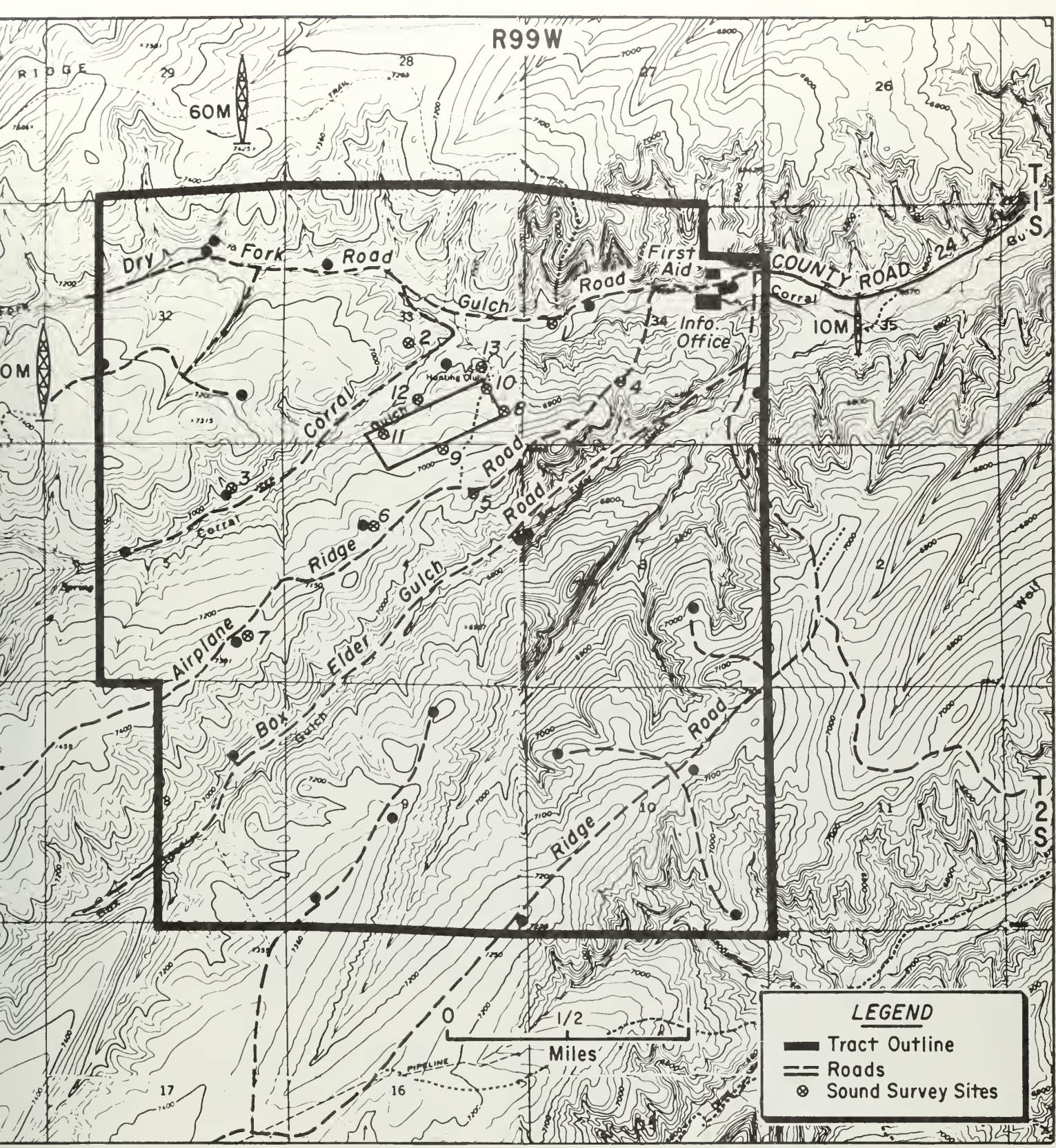


Figure 2-5. Environmental Sound Level Monitoring Sites, Series I, RBOSC, Tract C-a

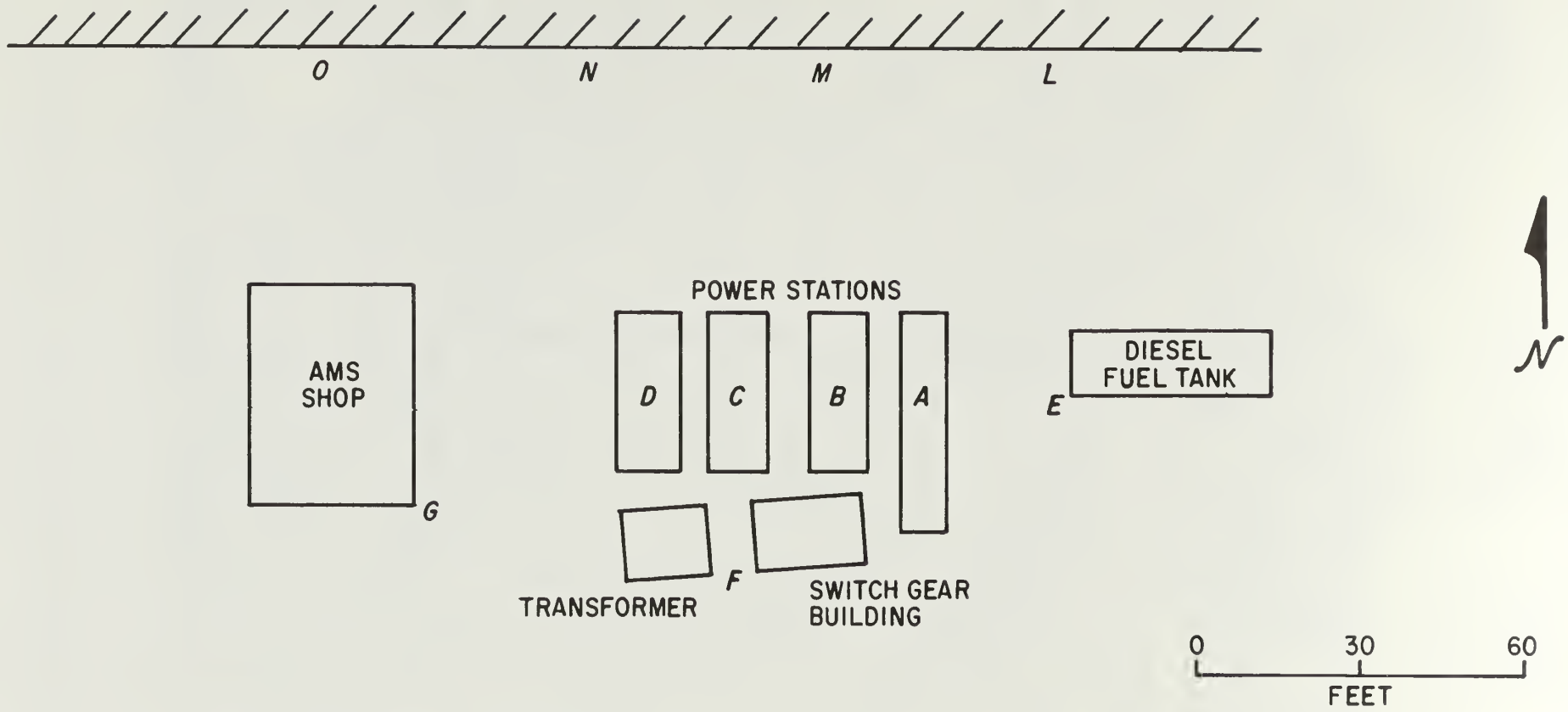


Figure 2-6 Environmental Sound Level Monitoring Sites, Series II, RBOSC, Tract C-a.

The sound level meter is calibrated before each survey. Wind speed (mph), wind direction, and time is recorded at the start of each survey. Highest and lowest values on the meter during a 30-second period is recorded for each site. Measurements are repeated five times. Comments noting unusual circumstances (i.e., jet overhead) and general conditions during the reading are recorded.

Sound level readings are reported as highest and lowest range for each of the five readings at each site and as the sound level average of all five samples. Averages are determined by adding all 10 values for each site and dividing by 10. Values are reported in decibels, A weighting (dBA), slow response.

3. Results and Discussion

Results of the two noise surveys are shown in Tables 2-5 and 2-3. Figures 2-3 and 2-4 are isopleths of sound level readings for the two sound level surveys.

The highest noise reading recorded was 110 dBA, which was recorded on five occasions, all inside the generator trailer with the generator in operation (Table 2-6). The highest reading in an unconfined space was 94 dBA at Site E, near the generator trailers (Figure 2-5).

Sound level averages taken during the January survey ranged from 45 - 66 dBA. These values reflected the spatial removal from site activities (Figure 2-7). Sound level averages taken during the March study were higher than during January, ranging from 82 - 110 dBA. However, these sites were in closer proximity to activity areas and were taken during periods of considerable activity.

Table 2-5. Sound Level Measurements, Series I - Tract Region, RBOSC Tract C-a. January 25, 1978.

Site	Time	Wind Speed (mph) Wind Direction	Sound Level Measurements (dBA, Slow Response) (30 sec) 1	2	3	4	5	Sound Level dBA Range	Sound Level dBA Average	Remarks
1	4:00 PM	10/W	62-68	40-58	38-42	42-54	40-72	38-72	52	Wind gusty, Front end loader drove past
2	4:15 PM	15/W	46-56	65-74	47-58	51-60	47-54	46-74	56	Jet overhead,gusty
3	4:35 PM	5/W	52-69	43-52	38-45	34-51	38-49	34-69	47	Jet overhead, gusty
4	1:02 PM	10/W	51-85	48-91	44-65	37-58	45-62	37-91	59	Heavy trucks on road, gusty
5	2:51 PM	10/W	34-50	38-47	37-64	34-62	36-43	34-64	45	Wind gusty
6	3:05 PM	10/W	32-42	45-59	38-60	35-48	32-64	32-64	46	Jet overhead, gusty
7	3:20 PM	10/W	31-52	34-61	52-63	46-61	43-62	31-63	51	Wind gusty
8	11:20 AM	5/W	53-58	49-57	46-52	46-51	48-54	46-58	51	Back-up alarms audible from site
9	11:30 AM	5/W	52-58	52-56	56-64	55-72	48-51	48-72	56	Bull dozer drove by 80' Wind gusty
10	1:15 PM	10/NW	48-55	52-58	52-66	47-64	45-58	45-66	55	Cement truck discharge 80', wind gusty
11	2:06 PM	15/W	58-68	34-47	38-63	55-63	32-44	32-68	50	Wind gusty
12	1:50 PM	15/W	60-62	59-64	60-63	60-65	59-62	59-65	61	Small portable generator operating (84dBA at 10') 75'
13	1:25 PM	5/W	65-66	65-68	66-68	64-68	64-67	64-68	66	Caterpillar Diesel Generator operating (88dBA at 10') 100'

Table 2-6. Sound Level Measurements, Series II - Shaft Region, RBOSC Tract C-a. March 17, 1978.

Site	Time	Wind Speed (mph) Wind Direction	Sound Level Measurements (dBA, Slow Response) (30 sec) 1	2	3	4	5	Sound Level dBA Range	Sound Level dBA Average	Remarks
A	11:10 AM	Not Measured	109-109	109-109	109-110	109-109	109-109	109-110	109	Inside trailer gen. operating
B	11:17 AM	Not Measured	109-110	109-109	109-109	109-109	109-110	109-110	109	Inside trailer gen. operating
C	11:23 AM	Not Measured	109-110	109-109	109-109	109-110	109-109	109-110	109	Inside trailer gen. operating
D	11:31 AM	Not Measured	105-105	105-106	105-106	105-106	105-106	105-106	105	Inside trailer gen. operating
E	11:54 AM	Not Measured	92-94	93-94	93-94	93-94	93-94	92-94	93	SW corner of fuel tank
F	11:03 AM	Not Measured	89-90	88-90	89-90	89-90	90-91	88-91	90	Between switch gear house
G	12:09 PM	Not Measured	85-86	85-85	85-86	85-86	85-86	85-86	85	SE corner of shop
H	12:30 PM	Not Measured	80-82	82-84	80-83	81-84	82-84	80-84	82	Entrance to util. tunnel
I	12:35 PM	Not Measured	78-81	79-80	78-80	80-81	79-81	78-81	80	Shaft entrance
J	12:39 PM	Not Measured	79-80	79-82	79-81	80-81	80-81	79-82	80	NE corner of hoist house
K	12:42 PM	Not Measured	81-81	81-82	81-81	82-82	82-83	81-83	82	NW corner of hoist house
L	12:13 PM	Not Measured	86-87	85-88	85-89	85-88	86-88	85-89	87	Top of bank NE from gen.
M	12:16 PM	Not Measured	86-90	86-89	86-90	86-89	87-90	86-90	88	Top of bank N from gen.
N	12:19 PM	Not Measured	86-86	86-87	85-87	86-87	85-88	85-88	86	Top of bank NNW from gen.
O	12:22 PM	Not Measured	80-80	80-84	80-82	80-83	79-83	89-83	82	Top of bank NW from gen.

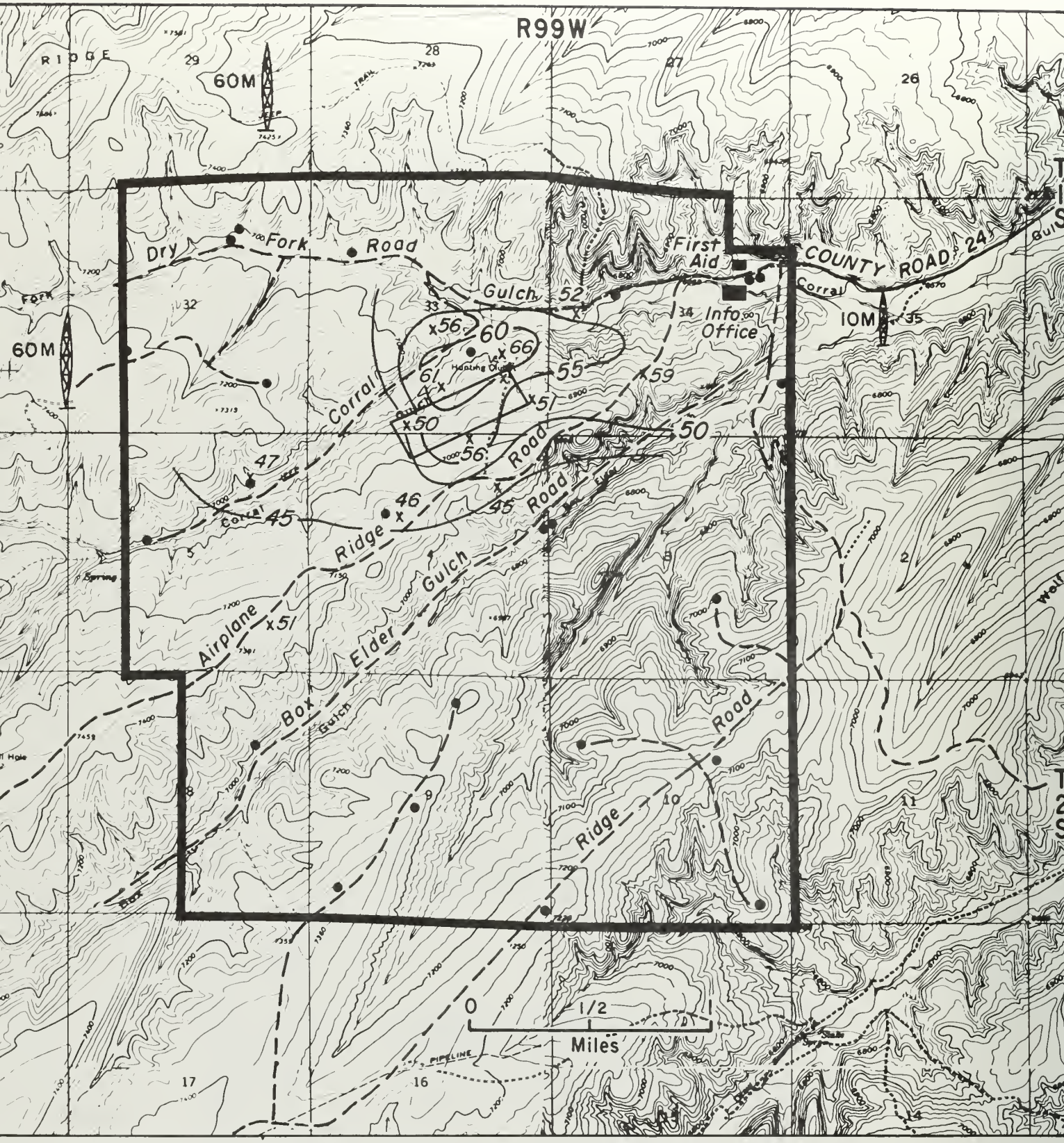


Figure 2-7. Isopleths of Sound Level Readings Around Tract C-a, Series I, RBOSC. January 25, 1978

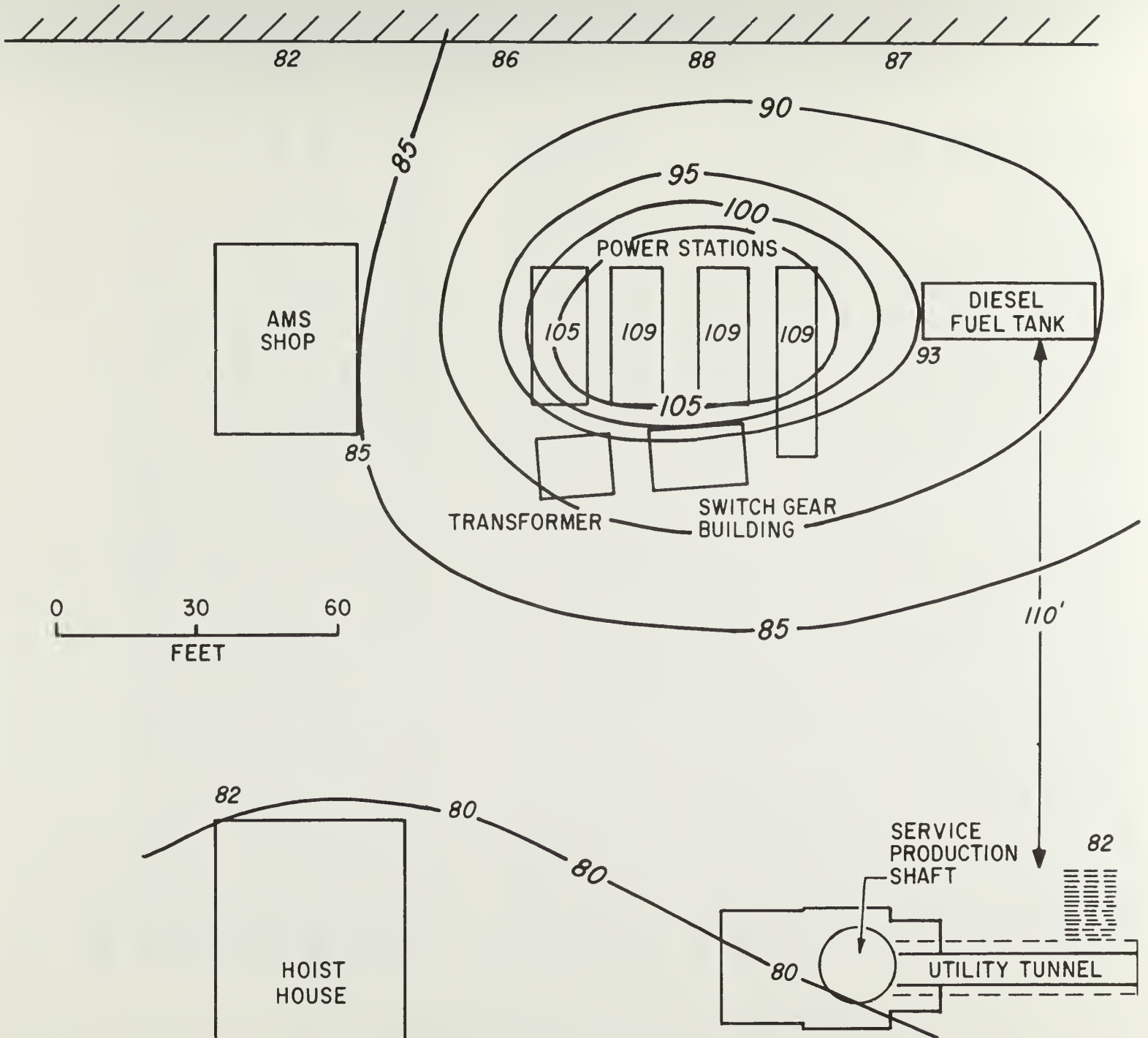


Figure 2-8. Isopleths of Sound Level Readings Around the Shaft Area, Series II, RBOSC.

2.3 DATA SUMMARIES AND CALIBRATION TECHNIQUES

The data summaries incorporated in the Appendices were prepared from data acquired by automatic monitoring instrumentation located on Tract C-a. The data are recorded on magnetic tape and analog strip chart recorders. Data from both recording systems were used to assemble the summaries. Quarterly field calibrations of the air quality instruments showed that no correction factors were required for the data. The threshold of detection of each instrument was established by the manufacturer's specifications and where the recorded concentration of any pollutant was below the reliable threshold of detection, a number equal to one half of the threshold value was substituted for the data point. This procedure is adopted from the EPA Quality Assurance Handbook, Air Pollution Measurement, Vol. 1. This applied to sulfur dioxide, hydrogen sulfide, nitrogen oxides and carbon monoxide data acquired through much of the data period.

Each instrument was tested at least once a week by inserting a zero pollutant concentration and at least one upscale concentration. These tests provided data on instrument drift and insured that the instrument would respond to a sensible level of pollutant concentration in the ambient air.

Span calibrations were conducted by supplying the methane/hydrocarbon and carbon monoxide analyzers with a known concentration of test gas. The concentrations of the test gas were determined either by vendor certification or by wet chemical tests using applicable Federal Reference methods. However, the applicability of the current Federal Reference Method for ozone using the Neutral Buffered Potassium Iodide (NBKI) technique has been shown to introduce a positive bias and questionable reproducibility. Consequently, at the end of this data period the ozone calibration was changed from the NBKI method to the gas phase titration method.

Calibration of the sulfur dioxide and nitrogen oxides instruments were conducted with permeation tube sources using a Monitor Labs calibrator traceable to NBS standards.

The meteorological system is calibrated on a semi-annual basis. The spring calibration, completed in April, included a routine replacement of all wind speed and wind direction sensors. No correction factors were required to adjust the data.

LITERATURE CITED

Dames & Moore, 1976. Quarterly Report - Spring, 1976 documentation of visibility in the Piceance Creek Basin for Rio Blanco Oil Shale Project and C-b Shale Oil Projects. p. 19.

Valley, S. L. Handbook of geophysics and space environments. Air Force Cambridge Research Lab., p. 7-4.

SECTION 3

TERRESTRIAL STUDIES

3.0 TERRESTRIAL STUDIES

The Terrestrial Studies MDP Monitoring Program is designed to detect and evaluate those impacts affecting the soil, vegetation or faunal components of the terrestrial ecosystem on or near RBOSC Tract C-a. An intensive two-year terrestrial program was conducted from October 1974 through September 1976 to characterize the biotic conditions existing prior to MDP development. Specific terrestrial baseline studies included soils, vegetation, range and browse, small mammals, large mammals, mammalian predators, reptiles and amphibians, avifauna, domestic livestock, and terrestrial invertebrates.

The terrestrial monitoring program is based on an assessment of current knowledge of MDP mining operations. Because this is a prototype operation, new information may become available which requires a modification of the outlined program. Therefore, this monitoring program should be viewed as a flexible one which may change as engineering design is refined and as additional ecological data are obtained.

3.1 SOILS

A. Trace Metals

Gaseous and particulate emissions containing toxic trace elements could be released from the MDP and Commercial Phase underground and surface retorts. Precautions will be taken during the MDP and Commercial Phases to prevent such emissions in accordance with appropriate federal and state air pollution regulations.

1. Objectives

The objective of the trace metal study is to detect any accumulation of trace metals in the soils and vegetation should trace metal emissions occur. Soil and vegetation samples will be collected and stored for future trace metal analysis. If source emission monitoring indicates that trace metal emissions are occurring, these stored samples will be analyzed to determine trace metal

content. Although projected gaseous and particulate emissions are not expected to contain trace metals, source emission monitoring is designed to determine if trace metals do occur in emissions. Soil samples are collected concurrently with the air quality monitoring program.

2. Methods

The methods to be followed for collection of the soils trace metal data were described in RBOSC MDP Monitoring Report 1.

3. Results

No results are available. The first soil sample collection is scheduled in August of 1981 (Table 3-1).

B. Conductivity

During the Commercial Phase, cooling towers will be operated in conjunction with surface retorting. Salt drift will result from this operation. An evaluation was made of the present conductivity levels in the Tract C-a soils during the baseline studies; saline soils were present.

1. Objectives

The soil conductivity studies are designed to detect any significant changes in soil salinity or conductivity levels which might result from an accumulation of salt drift from the towers. These data will be evaluated to determine if any such soil salinity changes are detrimental to plant growth.

2. Methods

The methods to be followed for collection of soil conductivity data were described in RBOSC MDP Monitoring Report 1.

Table 3-1. Terrestrial Studies Monitoring Schedule

Parameter	Location	Start Date	Frequency
Trace Metals (Collection & Storage of soils & vegetation samples)	See Figure 3-1	Aug. 1981	Annually
Soil Conductivity Studies	See Figure 3-2	Aug. 1981	Annually
Vegetation Mapping	Tract C-a & 5-mile Perimeter	May 1978	Annually
Range Productivity & Utilization	See Figure 3-3	April 1978 (establish plots)	Annually (in Sept.)
Browse Condition & Utilization	See Figure 3-3	May 1978	Annually
Mule Deer Density Studies	See Figure 3-4	Sept. 1977	Semi-annually (May, Sept.)
Feral Horse Abundance	Tract C-a & 3-mile Perimeter	Jan. 1978	Annually
Threatened & Endangered Species	Tract C-a & 3-mile Perimeter	Nov. 1978	Opportunistic

3. Results

No results are available. The first soil sample collection is scheduled in August of 1981 (Table 3-1).

3.2 VEGETATION, RANGE, AND BROWSE

A. Vegetation

1. Objectives

Construction and operation at Tract C-a may affect the local distribution of vegetation types as a result of dewatering and reinjection. The vegetation study is designed to monitor the distribution of vegetation on Tract C-a and adjacent areas to determine large-scale changes resulting from MDP development.

2. Methods

The methods to be followed for collection of these data were described in RBOSC MDP Monitoring Report 1.

3. Results

No results are available for this program; overflights to obtain color infrared aerial photography have been rescheduled for July of 1978.

B. Range

1. Objectives

MDP activities on Tract C-a may affect the range conditions on and near tract. These studies are designed to provide information on vegetative production which can be used to compare range productivity before and during modular development. Because the potential impacts are projected to be localized, the

range studies focus on areas on Tract C-a that are adjacent to MDP activities and that were previously used for grazing.

2. Methods

The methods to be followed for collection of range data were described in RBOSC MDP Monitoring Report 1.

Nine new range sampling sites (31 - 39) were established during May of 1978 (Figure 3-1). Range cages established during the Interim Monitoring Period were relocated parallel to the permanent transect of ocular plots at a distance of 5 m. Three additional cages were located at random along the transect parallel to the permanent ocular plots.

3. Results

No results are available; sampling will be conducted annually beginning September of 1978 (Table 3-1).

B. Browse

1. Objectives

Tract C-a development may reduce browse availability and therefore affect animal distribution in the vicinity of Tract C-a. The browse condition and utilization studies are designed to provide browse use information for areas adjacent to Tract C-a development.

2. Methods

The methods followed for collection of browse data were described in RBOSC MDP Monitoring Report 1.

Nine new browse transects (31 - 39) were established adjacent to the range transects (Figure 3-1) and measured in May of 1978.

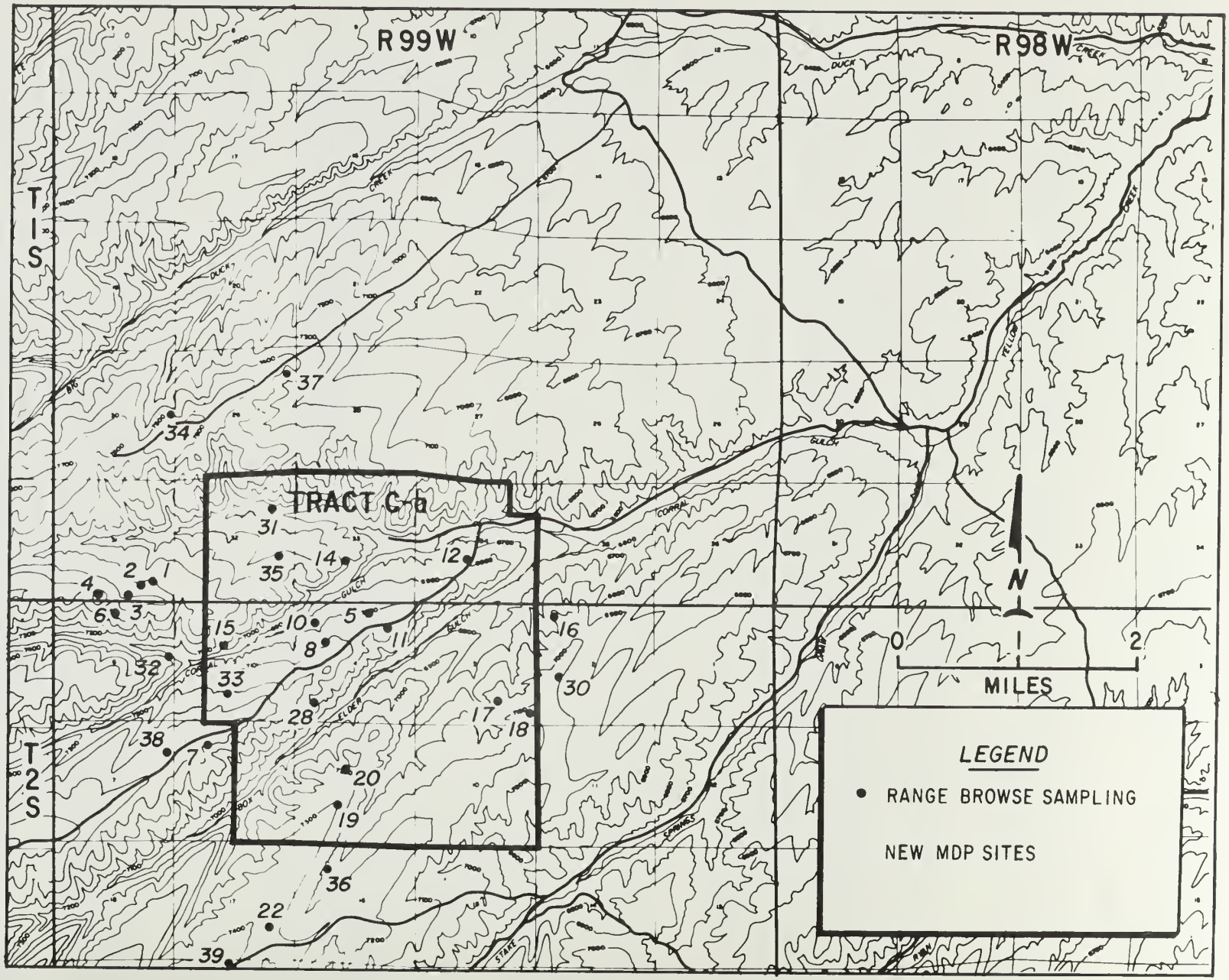


Figure 3-1. Sampling Sites of Range/Browse MDP Monitoring Sites

3. Results

The data obtained during May of 1978 (Appendix 3-2.1) are summarized in Table 3-2 by form class, age class, hedging class, and availability. A comparison of browse utilization sampled during Spring of 1976, 1977 and 1978 is presented in Table 3-3.

Table 3-3. A Comparison of Average Utilization (% Utilization)[1] in Three Vegetation Types During April 1976, May 1977 and May 1978 on and Near Tract C-a.

	April 1976	May 1977	May 1978
Mixed Brush	12	17	7
Pinyon-Juniper	27	24	31
Upland Sagebrush		6	25

[1]The comparison is for the habitat type in general; the same transects were not sampled during each period nor was the sample size equal.

a. Mixed Brush - In the mixed brush habitat the most frequently encountered shrub was serviceberry, but mountain mahogany had the greatest percent utilization during the period (Table 3-2). The level of hedging suggests that the mixed brush browse condition is good (Cole 1963) except for mountain mahogany which would be classified as poor. The average utilization (7 - 17%) during the past three years (Table 3-3) indicates that deer use is within "allowable use" for mild winters (Cole 1963) and did not change substantially after initiation of MDP mining activities.

b. Pinyon-Juniper - In the pinyon-juniper vegetation type, sagebrush was the most common shrub while bitterbrush and mountain mahogany were less common. Bitterbrush and mountain mahogany were the most heavily utilized shrubs (74 and 97%, respectively) (Table 3-2). The most heavily utilized shrub species have 32 - 87 percent of their individuals in the severe hedging class (Table 3-2) which classifies the condition of the pinyon-juniper as poor to very poor (Cole 1968). This conclusion may be misleading since it is based on a small sample size (17 - 36 individuals/plant species) but the high utilization (74 - 93%) exceeded

Table 3-2. Condition of Important Browse Species Sampled in Three Vegetation Types During May, 1978 in the Vicinity of RBOSC Oil Shale Tract C-a.

Habitat Type	Species	Number Plants Sampled	Average % Util.	Average % Avail.	Form Class Percentages								Age Class				Hedging Class		
					1	2	3	4	5	6	7	8	Seedling	Young	Mature	Decadent	Light	Moderate	Severe
MB	Serviceberry	129	8.8	80.7	44	10	8	16	12	7	-	3	6	12	53	29	63	22	15
	Sagebrush	61	4.1	73.8	30	25	-	11	16	8	-	10	0	5	61	34	50	41	9
	Snowberry	40	1.4	63.3	27	5	5	25	22	5	8	3	2	8	40	50	51	39	10
	Mountain Mahogany	14	13.0	79.6	22	36	14	-	14	7	-	7	14	-	57	29	15	54	31
	Pinyon Pine	6	2.5	88.3	50	33	-	17	-	-	-	-	-	-	100	-	67	-	33
PJ	Sagebrush	103	23.8	64.6	17	15	9	17	11	20	-	11	1	-	48	51	39	28	33
	Pinyon Pine	50	17.8	57.2	28	8	10	18	6	2	26	2	6	6	92	6	64	19	17
	Juniper	37	0.1	41.9	24	-	-	22	14	3	24	13	-	3	78	19	65	30	5
	Bitterbrush	36	73.7	54.2	3	17	19	5	28	17	-	11	-	-	39	61	10	58	32
	Mountain Mahogany	17	97.3	68.5	-	0	35	-	12	41	-	12	-	-	59	41	-	13	87
	Snowberry	4	6.0	77.5	-	25	75	-	-	-	-	-	-	-	75	25	-	25	75
	Serviceberry	3	-	-	33	-	-	-	-	33	33	-	-	-	67	33	-	50	50
SB	Sagebrush	234	26.3	62.1	18	15	6	11	13	16	-	21	-	-	50	50	37	36	27
	Serviceberry	12	13.5	79.2	58	17	-	8	-	-	-	17	8	17	50	25	90	10	-
	Snowberry	4	0	30	-	-	25	-	75	-	-	-	-	-	25	75	-	75	25

MB = Mixed Brush
PJ = Pinyon-Juniper
SB = Sagebrush

Form Classes

1 All available, little or no hedging
2 All available, moderately hedged
3 All available, severely hedged
4 Partially available, little or no hedging
5 Partially available, moderately hedged
6 Partially available, severely hedged
7 Unavailable
8 Dead

the 50 percent utilization indicated as acceptable for average conditions (Cole 1963). Mountain mahogany (which appears to be the preferred species on tract) exceeded even the 75 percent "allowable limit" for severe conditions. The average utilization of shrubs in pinyon-juniper habitat has ranged from 24 - 31 percent during the past three years (Table 3-3). The data suggest that MDP mining activities have not substantially affected browse utilization on and near tract C-a.

c. Upland Sagebrush - The upland sagebrush vegetation type consisted almost solely of sagebrush (Table 3-2).

Average utilization for sagebrush was 25 percent as compared to 6 percent in May of 1977 (Table 3-3). When individual transects are compared (Table 3-4), it is apparent that substantial increases in utilization occurred at Transects 8, 10, 15, 20 and 30 (Figure 3-1). Several of these two locations (20, 30) are in areas frequented by feral horses. Sagebrush is the only habitat type of the three types sampled which had a substantially different average percent utilization following initiation of the MDP activities. Since these changes appear related to feral horse use it is doubtful that MDP activities affected utilization in the sagebrush areas.

3.3 Fauna

A. Mule Deer

1. Objectives and Rationale

Mule deer are the most important game species in Colorado in terms of recreational use and money expended by hunters. The Piceance Creek Basin mule deer herd is one of the largest migratory mule deer herds in North America. Tract C-a is within the Piceance Creek Basin and Colorado Division of Wildlife's (CDOW) Game Management Unit 22.

Moderate numbers of mule deer occur on Tract C-a during fall and spring migration periods and during mild winters; at other times mule deer are relatively

Table 3-4. Rank of Each Browse Utilization Transect Based on Total Utilization Within Each Vegetation Type During 1976 - 1978 On and Near Tract C-a.

	December 1976 Transect No. (% Util.)[1]	May 1977 Transect No. (% Util.)[1]	August 1977 Transect No. (% Util.)[1]	May 1978 Transect No. (% Util.)[1]
Mixed Brush	6 (660)	6 (785)	4 (250)	6 (250)
	3 (217)	1 (437)	6 (230)	4 (115)
	1 (136)	2 (352)	1 (155)	2 (110)
	2 (117)	3 (270)	3 (105)	1 (100)
	4 (48)	4 (230)	2 (100)	3 (60)
Pinyon-Juniper	17 (1048)	11 (1080)	17 (460)	11 (995)
	18 (930)	17 (1060)	12 (320)	18 (955)
	12 (870)	18 (1050)	19 (160)	17 (930)
	11 (699)	12 (950)	18 (85)	12 (950)
	16 (200)	16 (610)	11 (75)	19 (640)
	19 (196)	19 (315)	16 (65)	7 (275)
	7 (121)	7 (170)	7 (10)	16 (210)
Upland Sagebrush	20 (503)	30 (545)	30 (315)	30 (1255)
	30 (370)	22 (220)	22 (100)	10 (880)
	22 (127)	8 (130)	20 (45)	20 (525)
	8 (82)	20 (90)	8 (15)	8 (490)
	28 (47)	15 (60)	10 (9)	15 (375)
	10 (9)	28 (25)	28 (0)	22 (280)
	15 (2)	10 (9)	15 (0)	14 (90)
	14 (0)	14 (0)	14 (0)	28 (0)

[1] Sum of percent utilization for 25 shrubs sampled along a transect.

uncommon on the tract. Consideration of the possible effects of Tract C-a oil shale development on mule deer is an integral part of RBOSC's Fish and Wildlife Management Plan.

The objectives of RBOSC's mule deer monitoring program are to obtain an index of mule deer density in a 9 x 9 mile (81 sq mi) study area centered on Tract C-a (Figure 3-2), to compare indices of mule deer density from the study area with those from the Game Management Unit 22, and, if possible, to compare differences in mule deer densities within various portions of the study area.

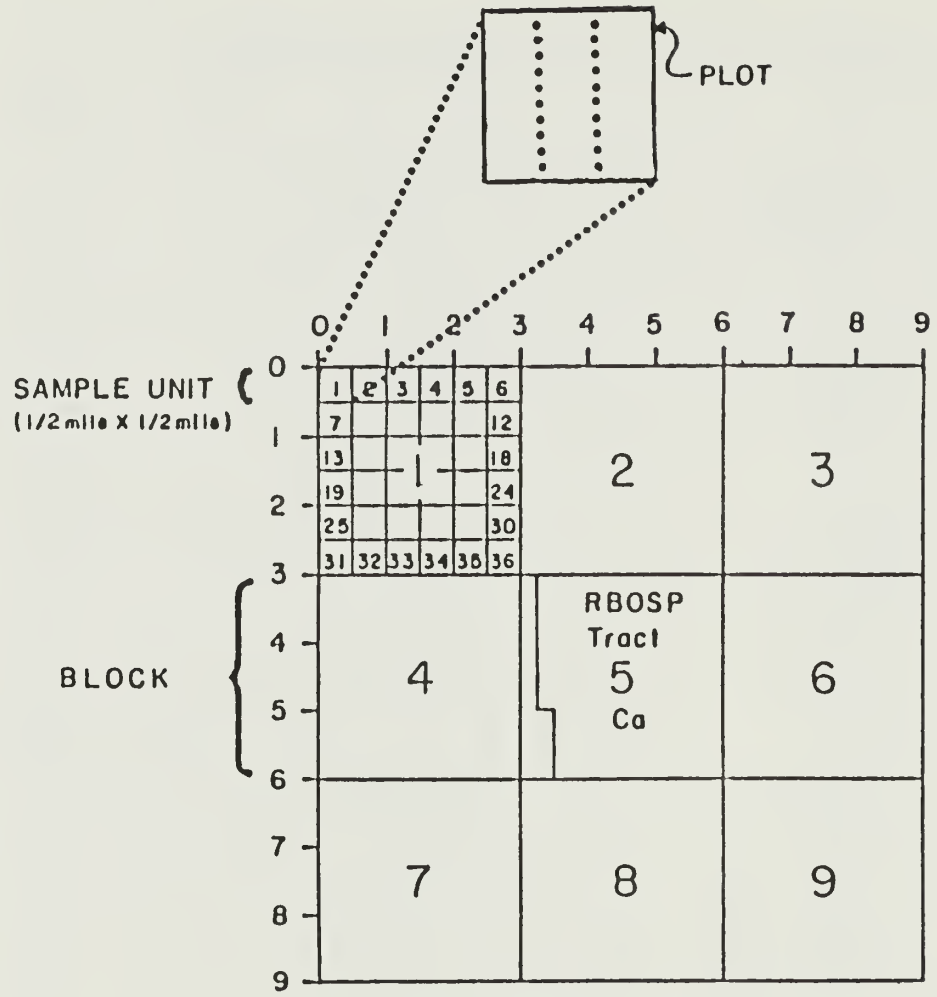
2. Methods

Mule deer density estimates can be calculated from pellet-group density data as mule deer defecate a more or less uniform number of times daily (Neff 1968). The number of pellet-groups per unit area, days of use by deer, and deer per unit area in the Tract C-a study area are being determined as described by Overton (1971). The methods followed for collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated herein.

3. Results and Discussion

Mule deer pellet groups were counted in 20 plots in each of seven 160 acre sample units in each of the nine square mile blocks comprising the Tract C-a study area (Figure 3-2). Summary pellet group information from the Spring, 1978 sample period is presented in Table 3-5. Detailed data on each plot are presented in computer print-out format as Appendix 3.3-1. Complete analyses of those data are being conducted and synthesized. Analyses of deer use days and indices of deer densities for sample units, blocks, and the entire study area will be reported in the December 1978 semi-annual report. Comparisons of deer population parameters on the Tract C-a study area with similar available parameters about deer populations in the Piceance Basin will also be included in that report.

Based on the data presented in Table 3-5, it appears that portions of the study area are important deer wintering areas and/or migration routes. The



plot = ca. 100 square ft (1/1000 ha)
sample unit = 160 acres (ca. 64 ha)
block= 9 square miles

20 plots per sample unit
36 potential sample units per block
9 blocks in the RBOSC Study Area

Figure 3-2. Study Area for Mule Deer Pellet-Group Counts, RBOSC Modular Development Phase Monitoring Program

Table 3-5. Mule Deer Pellet Groups Counted on RBOSC Tract C-a Study Area, Spring 1978

Block and Sample Unit	Number of Pellet Groups in Sample Unit	Total Number of Pellet Groups in Block	Average Number of Groups Per Sample Unit For Each Block	Average Number of Deer Per Square Mile For Each Block[1]
1-05	3			
1-11	12			
1-16	9			
1-20	7			
1-23	11			
1-26	16			
1-31	12	70	10.00	40.9
2-5	3			
2-6	4			
2-15	12			
2-17	6			
2-24	9			
2-28	12			
2-34	6	52	7.43	30.4
3-1	8			
3-11	22			
3-14	7			
3-17	7			
3-18	10			
3-19	7			
3-34	9	70	10.00	40.9
4-1	12			
4-8	6			
4-13	1			
4-14	11			
4-18	3			
4-23	9			
4-25	6	48	6.86	28.0
5-8	16			
5-13	4			
5-15	21			
5-27	34			
5-28	16			
5-29	15			
5-36	5	111	15.86	64.8

Table 3-5. (Continued)

Block and Sample Unit	Number of Pellet Groups in Sample Unit	Total Number of Pellet Groups in Block	Average Number of Groups Per Sample Unit For Each Block	Average Number of Deer Per Square Mile For Each Block[1]
6-8	14			
6-11	7			
6-14	10			
6-27	9			
6-30	27			
6-32	2			
6-35	2	71	10.14	41.5
7-16	8			
7-17	14			
7-19	0			
7-22	7			
7-28	10			
7-32	1			
7-34	3	43	6.14	25.1
8-3	15			
8-5	1			
8-11	1			
8-13	5			
8-14	6			
8-27	3			
8-34	3	34	4.86	19.9
9-3	1			
9-7	1			
9-9	3			
9-15	0			
9-21	1			
9-30	1			
9-35	3	10	1.43	5.8

1) Assuming 240 days in the winter sampling period, presence of deer throughout the period, and 13.2 pellet groups per deer per day. More detailed analyses per plot are being conducted and will be reported in the December 1978 Semi-Annual Report.

non-uniform distribution of deer throughout the study area is expected. Many environmental factors govern the population density and distribution of deer on a given range for a given season, and data from one season's sampling do not provide sufficient information from which meaningful conclusions can be drawn. Due to the sampling design, any significant changes in distribution and trends in deer population, as expressed by densities of pellet groups, will be determined from the data gathered during the MDP Environmental Monitoring Program on the Tract C-a study area.

B. Feral Horses

1. Objectives and Rationale

Feral horses occur on and in the vicinity of Tract C-a. These horses are protected under federal law and are under the jurisdiction of the BLM. Feral horses compete with cattle and, to a lesser extent, with mule deer for available forage. The objective of feral horse monitoring studies is to provide qualitative information concerning the status of feral horses in the RBOSC study area (i.e., same study area as for mule deer).

2. Methods

The methods followed for collection of data on feral horses were described in RBOSC MDP Monitoring Report 1 and are not repeated herein.

3. Results

Feral horses on the Tract C-a study area were counted from a fixed wing aircraft in January, 1978. Seven bands of horses totaling 53 individuals were observed in the study area. BLM personnel (Lawthorn, personal communication) estimate that approximately 60 percent of the horses in areas with topography and vegetation cover similar to that of the study area are observed from fixed-wing aircraft. The total number of horses on the Tract C-a study area during January, 1978 may have been between 80 and 100.

Observation of horses were recorded during the mule deer pellet-group sampling in May, 1978 (Figure 3-3). During that period 72 observations of bands of horses were made (Table 3-6). An additional 39 observations of horses were made by other NUS personnel during the study period. Many of these observations were the same band or of individuals from more than one band temporarily together. Reactions of bands to the presence of a truck or person varied from complacency in areas where traffic was frequent to very skittish in areas of reduced human activity. Some injured and diseased horses and several carcasses were observed in the area. Further observations and the estimated number of horses in the Tract C-a study area will be reported in the December, 1978 semi-annual report.

C. Threatened and Endangered Species

Baseline and interim monitoring studies indicate that Tract C-a does not provide critical habitat for any state or federally endangered species. Greater sandhill cranes were observed during the baseline studies on 84 Mesa, at the Stake Springs impoundment, and east of 84 Ranch. A whooping crane was sighted east of 84 Ranch. Neither of these species was observed during the reporting period.

Figure 3-3

FERAL HORSE OBSERVATIONS

RBOSP - Tract C-a, Colorado

NUS CORPORATION

OBSERVER Clark/Ruiter Date 15 May 1978 Time 5:30 p.m.

WEATHER: Temp _____ Wind _____ mph from _____ Precipitation _____

LOCATION: NW ¼ of the NW ¼ of Section 15

Township 2S Range 99W Landmarks _____

near plot 5 or 6 on 8-05 mule deer sample unit

HORSES IN BAND: 5 Adults _____ Juveniles ? Males _____ Females _____; Total Number 5

DISTINGUISHING CHARACTERISTICS OF BAND/IDENTITY 1 white w/black mane and tail, 2 blacks, 1 bay and 1 chestnut; no foals observed unless chestnut was foal-probably yearling.

BAND ACTIVITY/BEHAVIOR on S slope in mixed PJ and Sage - no special behavior - were 1/3 mile truck and seemed skittish.

REMARKS _____

Table 3-6. Feral Horses Observed on Tract C-a Study Area During Spring 1978 Mule Deer Pellet Group Sampling

Date	Time	Location			Number of Horses Seen in Band
		Section	Township	Range	
5/15	8:30 a	18	1S	98W	13
5/15	1:00 p	15	1S	99W	15
5/15	5:00 p	15	2S	99W	10
5/15	5:30 p	15	2S	99W	5
5/16	11:30 p	1	2S	100W	6
5/16	11:30 p	2	2S	100W	5
5/16	3:30 p	2	2S	100W	5
5/16	3:30 p	36	1S	100W	6
5/16	3:30 p	36	1S	100W	5
5/16	4:00 p	17	2S	99W	3
5/17	10:00 a	19	2S	99W	7
5/17	12:00 p	24	2S	100W	7
5/17	1:30 p	15	2S	99W	6
5/17	1:30 p	16	2S	99W	5
5/17	1:30 p	15	2S	99W	3 1/
5/17	2:00 p	26	2S	100W	12
5/17	5:00 p	25	2S	100W	8
5/18	8:00 a	15	2S	99W	6
5/18	8:30 a	15	2S	99W	5
5/18	10:30 a	15	2S	99W	10
5/18	11:00 a	14	1S	99W	19
5/18	11:30 a	28	1S	99W	4

1/ only individuals which could be identified from larger band.

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SECTION 4

AQUATIC STUDIES

In October 1977, RBOSC initiated the MDP Aquatic Monitoring Program. This program was based upon a detailed analysis of the RBOSC aquatic baseline data and upon projected potential impacts of modular development on Tract C-a.

A total of six sampling sites has been chosen for the MDP Aquatic Monitoring Program (Figure 4-1). The sampling sites include:

- Station 13 (spring-brook habitat) at the USGS gaging station in Corral Gulch (east)
- Station 14 (pond habitat) in Corral Gulch (east)
- Station 20 (spring-brook habitat) at the USGS gaging station on Yellow Creek
- Station 21 (spring-brook habitat) on Yellow Creek below the USGS gaging station
- Station 27 and 29 (White River back channel habitats) near the confluence of Yellow Creek with the White River.

Sampling, at least initially, is being conducted five times per year to allow comparison of monitoring and baseline data. Sampling is scheduled for April, June, July, August, and October during 1978 and during subsequent years of RBOSC modular development (Table 4-1). This report includes the results of the April 1978 aquatic biological sampling.

4.1 ABIOTIC COMPONENTS

A. Physical Measurements

1. Objectives

The objectives of taking physical measurements during the MDP Aquatic Monitoring studies are to monitor selected physical characteristics of the streams at each sampling site and to relate these characteristics to baseline chemical and biological conditions. The physical measurement program also includes those chemical parameters which are measured in conjunction with field sampling.

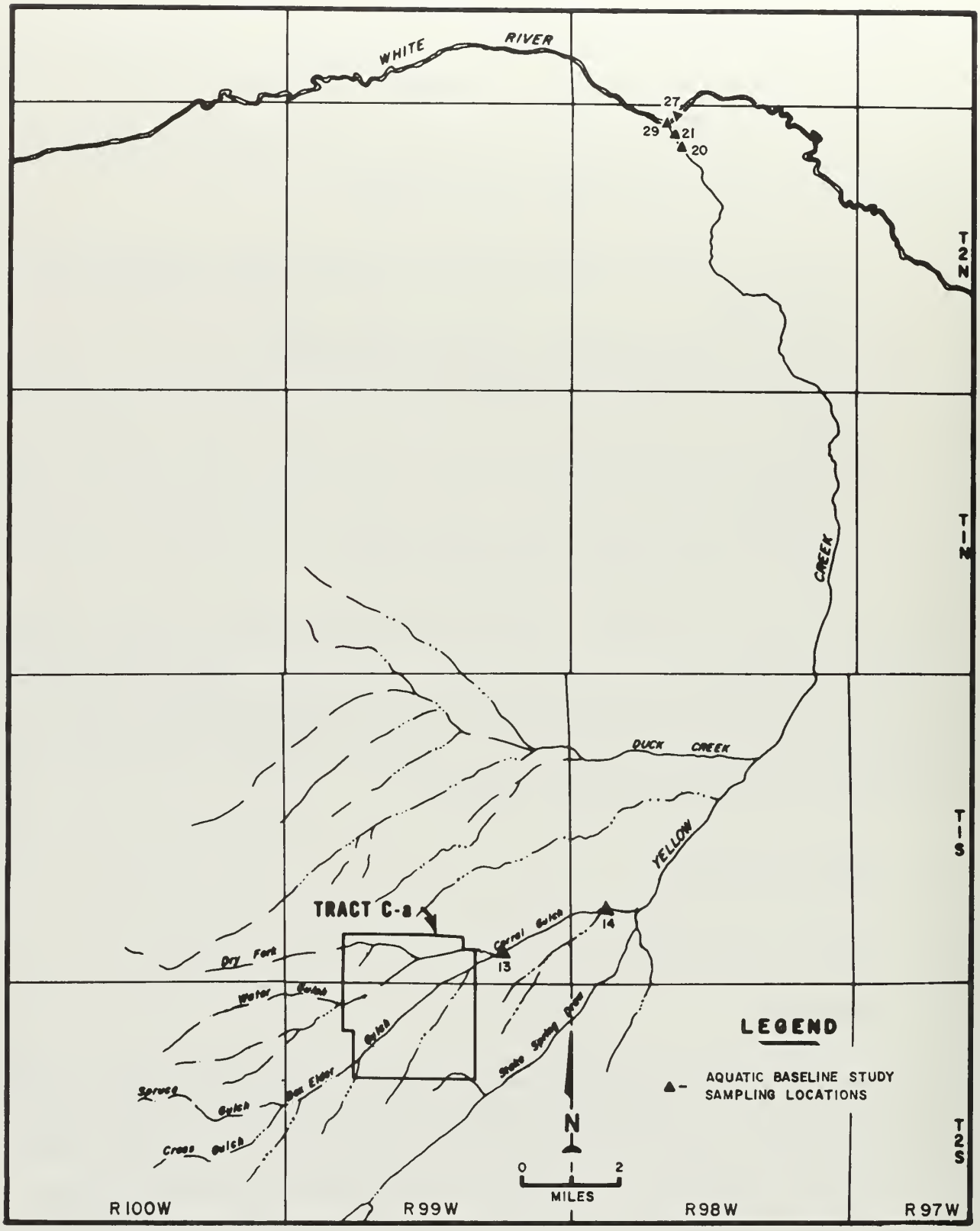


Figure 4-1. Locations of Aquatic Sampling Sites, RBOSC, Tract C-a.

Table 4-1. Aquatic Studies Monitoring Schedule

Parameter	Location	Start Date	Frequency
Abiotic Component			
Physical Measurements			
Stream Velocity Turbidity Dissolved Oxygen pH Specific Conductance Depth Width Stream Substrate	Stations 13, 14 20, 21, 27, 29 (See Figure 4-1)	Oct. 1977	5 times/year (Apr., June, July, Aug., Oct.)
Water Quality Measurements (White River)			
Boron Calcium Chloride Fluoride Magnesium Nitrate Orthophosphate Potassium Total Phosphate Silica Sulfate Sodium Alkalinity Total Dissolved Solids	Stations 27, 29 (See Figure 4-1)	Oct. 1977	5 times/year (Apr., June, July, Aug., Oct.)
Biotic Component			
Periphyton	Stations 13, 14 10, 21, 27, 29 (See Figure 6)	Oct. 1977	5 times/year (Apr., June, July, Aug., Oct.)
Benthos	Stations 13, 14 20, 21, 27, 29 (See Figure 4-1)		5 times/year (Apr., June, July, Aug., Oct.)

The physical parameters selected for these monitoring studies are those which may be influenced by development (e.g., increases in siltation and turbidity and decreased flows) and which have been shown to be of particular significance to the important aquatic organisms observed during baseline studies.

2. Methods

The methods followed for collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated here.

3. Results and Discussion

A comparison of the results of the physical measurements during the April 1975 and 1976 aquatic baseline and the April 1978 MDP studies is presented in Table 4-2. Results of the April 1978 measurements are presented in Appendix 4-1.

The physical conditions observed during April 1978 at Stations 13 and 14 were generally similar to those observed during baseline, except that water temperatures and velocities were generally higher during the MDP sampling. This can likely be attributed to the fact that flows in this area of Corral Gulch were in large measure due to discharge from hydrologic pump tests.

In Yellow Creek (Stations 20 and 21), conductivities were higher during the April 1978 sampling than during April 1975 or 1976 and dissolved oxygen levels were lower in 1978 than in April 1975 or 1976.

In the White River (Stations 27 and 29) the physical conditions observed in April 1978 were generally similar to those observed during previous years; however, water temperatures were lower in 1978 than in either 1975 or 1976.

Table 4-2 . Comparison of Physical and Chemical Characteristics of Streams from RBOSC MDP Studies (April 1978) and RBOSC Baseline Studies (April 1975 and 1976).

Parameter	1975	1976	1978
	STATION 13		
Water Temperature (^{o}C)	9	13	17
Conductivity (μmhos/cm)	1,730	1,150	1,500
Dissolved oxygen (mg/l)	5.2	7.8	5.1
Alkalinity, total (mg/l)	716	435	584
pH	8.3	7.5	8.3
Substrate[1]	Gr,Si	Gr,Sa	Gr
Width	36"	48"	42"
Depth	3"	4"	6"
Velocity (ft/sec)	1.0	1.4	2.0
	STATION 14		
Water Temperature (^{o}C)	5	9	16
Conductivity (μmhos/cm)	1,800	1,750	1,400
Dissolved oxygen (mg/l)	11.1	9.7	10.1
Alkalinity, total (mg/l)	492	546	424
pH	8.4	7.9	8.4
Substrate[1]	Si	Sa	Sa,Si,De[2]
Width	3"	18"	6"
Depth	2"	4"	6"
Velocity (ft/sec)	0.5	1.2	1.0

Table 4-2. (Continued)

Parameter	1975	1976	1978
	STATION 20		
Water Temperature (°C)	14	19	16
Conductivity (µmhos/cm)	3,700	4,000	4,200
Dissolved oxygen (mg/l)	9.4	9.4	8.2
Alkalinity, total (mg/l)	1,291	1,632	1,444
pH	8.6	8.7	8.1
Substrate[1]	Gr,Si,Sa	Gr	Co,Gr
Width	12'	5'	3'
Depth	4"; 3"	4"	4"
Velocity (ft/sec)	1.6; 1.0	1.1	1.5
	STATION 21		
Water Temperature (°C)	14	18	13
Conductivity (µmhos/cm)	3,700	3,900	4,200
Dissolved oxygen (mg/l)	8.9	10.2	6.9
Alkalinity, total (mg/l)	1,306	1,658	1,532
pH	8.6	8.7	8.7
Substrate[1]	Gr;Si	Gr	Gr;Sa
Width	5'5"	6'	4'
Depth	5";3"	4"	4"
Velocity (ft/sec)	1.3;1.7	0.9	1.0

Table 4-2. (Continued)

Parameter	1975	1976	1978
	STATION 27		
Water Temperature (°C)	15	17	9
Conductivity (µmhos/cm)	850	650;640;650[2]	700;700;700[2]
Dissolved oxygen (mg/l)	9.8	10.6	9.6
Alkalinity, total (mg/l)	207	188	184
pH	8.5	8.4	8.2
Substrate[1]	GR,SC°	Co	Co,Si
Width	46'6"	51'	51'
Depth	2";23";4"[2]	4";22";8"[2]	8";10";4"[2]
Velocity (ft/sec)	3.0;2.8;2.5[2]	1.2;1.0;0.7[2]	1.2;1.9;1.4[2]
	STATION 29		
Water Temperature (°C)	13	11	9
Conductivity (µmhos/cm)	850	730;800;1,150[2]	750;800;900[2]
Dissolved oxygen (mg/l)	10.1	10.5	9.3
Alkalinity, total (mg/l)	207	186	214
pH	8.4	8.4	8.2
Substrate[1]	GR,SC	GR,Sa	Co, Si
Width	20'10"	25'	36'
Depth	1";11";1"[2]	4";12";2"[2]	8";10";14"[2]
Velocity (ft/sec)	1:9;3:6	2.8;3.9;1.9[2]	2.4;2.7;2.3[2]

[1]Substrate abbreviations:

Gr = Gravel
Sa = Sand
De = Detritus
Co = Cobble
Cl = Clay
Si = Silt

[2]Measurements made at side, center, side, respectively.

B. Water Quality Measurements

1. Objectives

The objective of this aspect of the aquatic monitoring studies is to monitor those chemical characteristics which baseline data-analyses (RBOSP Final Environmental Baseline Report 1977) have shown to contribute most to the natural variability in White River water quality and thereby to assess natural variability in water quality. Water quality studies in other surface waters of the site are included in hydrology studies (Section 5).

2. Methods

The methods followed for collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated here.

3. Results and Discussion

Results of the April 1978 water quality analysis of the White River waters above and below the confluence with Yellow Creek are presented in Appendix 4-2.

Tables 4-3 and 4-4 include a comparison of the results of the April 1978 water quality analyses of White River waters above and below the confluence with Yellow Creek with those obtained during the baseline studies. It should be noted that the sampling locations utilized during the MDP monitoring are not identical to those used during baseline studies. However, baseline data indicated that adjacent upstream and adjacent downstream stations exhibited similar water quality. Therefore such comparisons are considered valid.

Tabel 4-3 . Comparison of Water Quality Data from the White River (Upstream of Yellow Creek) from RBOSP Aquatic Baseline (1975) and MDP (1978) Studies. (Results are expressed as the means of two replicates and are mg/l unless otherwise noted.)

Parameter	1975	1978
	Station 25	Station 27
Boron (B), diss	<0.5	<0.5
Calcium (Ca), diss	66	71
Chloride (Cl), diss	28	29
Flouride (F), diss	0.60	0.27
Magnesium (Mg), diss	24	24
Nitrate (n), diss	<0.2	<0.2
Phosphorus, Ortho (P), diss	<0.01	0.01
Phosphorus, total (P), diss	0.28	0.02
Potassium (K), diss	2.7	2.1
Silica (Si), diss	6.1	6.3
Sodium (Na), diss	59	47
Solids, diss	476	444
Sulfate (S)	55	49
Turbidity (JTU)	93	4

diss = dissolved

Tabel 4-4 . Comparison of Water Quality Data from the White River (Downstream of Yellow Creek) from RBOSP Aquatic Baseline (1975) and MDP (1978) Studies. (Results are expressed as the means of two replicates and are mg/l unless otherwise noted.)

Parameter	1975	1978
	Station 34	Station 29
Boron (B), diss	<0.5	<0.5
Calcium (Ca), diss	62	71
Chloride (Cl), diss	28	32
Flouride (F), diss	0.70	0.28
Magnesium (Mg), diss	22	27
Nitrate (n), diss	<0.2	<0.2
Phosphorus, Ortho (P), diss	<0.01	0.01
Phosphorus, total (P), diss	0.18	0.02
Potassium (K), diss	2.6	2.3
Silica (Si), diss	6.2	6.3
Sodium (Na), diss	58	64
Solids, diss	467	483
Sulfate (S)	53	51
Turbidity (JTU)	69	3

diss = dissolved

4.2 BIOTIC COMPONENTS

A. Periphyton

1. Objectives

The objectives of periphyton studies are to monitor species composition, relative abundance, biomass, and diversity of periphyton and to assess the effects of site development on communities of these organisms.

2. Methods

The methods followed for collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated here.

3. Results and Discussion

Total mean cell densities of the most abundant algal taxa found in April periphyton samples collected during RBOSC Aquatic Baseline (1975, 1976) and MDP (1978) studies are presented in Table 4-5. A comparison of mean dry and organic weights of these periphyton samples are presented in Table 4-6. Species composition, algal densities, and biomass data for April, 1978 are presented in Appendices 4-3.1, 4-3.2, and 4-3.3, respectively.

At Station 13 the mean total algal cell densities for the most abundant taxa in the April 1978 periphyton collections were much lower than those observed during April sampling in 1975 and 1976, as indicated in Table 4-5. The mean organic weight of periphyton observed in April, 1978 was also lower than the weights observed in either 1975 or 1976, as indicated in Table 4-6.

Achnanthes minutissima and Navicula cryptocephala were among the dominant taxa at Station 13 in April of each year. Other taxa which were common or abundant each year were Bicoeca lacustris and Nitzschia frustulum.

Table 4- 5. Comparison of Mean Densities of the Most Abundant Algal Species Observed in the Periphyton During RBOSC MDP Studies (April 1978) and RBOSC Aquatic Baseline Studies (April 1975 and 1976). Densities are expressed in cells/mm^2 except data for filamentous taxa which are expressed as the number of 50 μm units.)

Taxa	1975	1976	1978
	Station 13		
Achnanthes lanceolata	288		
A. minutissima	4,661	14,765	94
Bicoeca lacustris		631	162
Gomphonema intricatum		12,929	
Meridion circulare		3,240	
Navicula arvensis			25
N. cryptocephala	830	2,081	14
N. pelliculosa		15,230	
Nitzschia capitellata		1,008	
N. frustulum	125		23

Table 4-5. (Continued)

Taxa	1975	1976	1978
	Station 14		
Achnanthes lanceolata	247	-	-
A. minutissima	4,954	573	-
Bicoeca lacustris	-	3,471	-
Cymbella affinis	199	-	-
Gomphonema intricatum	-	180	300
Navicula arvensis	199	177	584
N. cryptocephala	435	339	363
N. pelliculosa	-	957	607
N. viridula	168	-	-
Nitzachia capitellata	-	294	1,642
N. denticulata	1,688	-	-
N. frustulum	1,069	-	431
N. palea	171	-	-
Synedra amphicephala	135	-	-

Table 4-5. (Continued)

Taxa	1975	1976	1978
	Station 20		
Achnanthes minutissima	1,337	-	6,226
Cymbella affinis	63	-	-
Fragilaria vaucheriae	108	-	-
Navicula pelliculosa	518	1,334	21,965
Nitzschia capitellata	-	190	-
N. frustulum	-	-	1,635
N. holsatica	-	80	-
N. microcephala	-	-	355
N. palea	45	-	909
Surirella ovata	243	1,035	-
Synedra amphicephala	-	1,350	-

Table 4-5. (Continued)

Taxa	1975	1976	1978
	Station 21		
Achnanthes minutissima	977	114	807
Fragilaria vaucheriae	162	118	-
Navicula pelliculosa	3,996	547	15,634
Nitzschia capitellata	-	283	-
N. frustulum	40	-	851
N. holsatica	-	136	-
N. microcephala	-	-	172
N. palea	58	-	1,791
Surirella ovata	266	1,276	219
Synedra amphicephala	-	1,149	-

Table 4-5. (Continued)

Taxa	1975	1976	1978
	Station 27		
Amphora ovalis var. pediculus	-	1,632	-
Epithemia sorex	911	1,371	-
Gomphonema olivaceum	675	-	2,945
Navicula cryptocephala	2,329	1,144	401
N. pelliculosa	-	-	1,951
N. tripunctata	1,463	816	26
N. viridula	2,767	4,477	403
Nitzschia dissipata	1,957	1,519	259
N. frustulum	-	997	-
Surirella ovata	540	-	-
Calothrix spp.	-	1,020	-

Table 4-5. (Continued)

Taxa	1975	1976	1978
	Station 29		
Achnanthes minutissima	731	-	23
Amphora ovalis var. pediculus	-	874	3
Cymbella sinuata	-	180	-
Epithemia sorex	1,192	117	-
Gomphonema olivaceum	574	1,115	1,768
Navicula cryptocephala	889	540	545
N. pelliculosa	-	-	1,977
N. tripunctata	292	204	78
N. viridula	1,204	2,737	560
Nitzschia dissipata	1,474	986	590
N. frustulum	101	187	103
Surrirella ovata	-	243	3
Calothrix spp.	157	-	-
Lyngbya spp.	259	-	-
Plectonema spp.	250	-	-

Table 4-6. Comparisons of Mean Dry and Organic Weights of Periphyton During RBOSC MDP Studies (April 1978) and RBOSC Aquatic Baseline Studies (April 1975, 1976).

Station	1975		1976		1978	
	Dry Weight ($g/50\ cm^2$)	Organic Weight ($g/50\ cm^2$)	Dry Weight ($g/50\ cm^2$)	Organic Weight ($g/50\ cm^2$)	Dry Weight ($g/50\ cm^2$)	Organic Weight ($g/50\ cm^2$)
13	0.3996	0.0509	0.6250	0.1297	0.4674	0.0348
14	2.4702	1.3591	1.0064	0.0617	4.0311	0.1470
20	0.6236	0.0742	0.3026	0.0423	0.4846	0.0786
21	0.7291	0.1068	0.2610	0.0377	1.8944	0.3004
27	5.2768	0.4431	2.9986	0.3243	0.9806	0.0520
29	3.7812	0.3468	1.9285	0.1165	0.7512	0.0562

The lower mean total cell densities and the lower mean organic weight observed in 1978 may be attributed to the higher flows and consequent scouring of periphyton due to discharge of pump test waters into Corral Gulch.

In April 1978, mean total cell densities for the most abundant taxa were lower at Station 14 than during 1975 or 1976 (Table 4-5). The mean organic weight of periphyton observed at Station 14 in April 1978 was intermediate to the values observed during the baseline studies (Table 4-6).

Navicula arvensis and Navicula cryptocephala were among the dominant taxa at Station 14 in April of each year of study. Other taxa which were common or abundant during two sampling included Gomphonema intricatum, Navicula pelliculosa, Nitzschia capitellata, and Nitzschia frustulum.

No distinct trends in algal species composition cell densities or organic weights are evident from the April to April comparisons at Station 14.

At Stations 20 and 21 (in Yellow Creek) the periphyton communities were generally similar in April 1978. Total mean cell densities for the dominant taxa were higher at both Stations in 1978 than during the April samplings in either 1975 or 1976. The organic weight of periphyton at Station 21 was higher in April 1978 than in either of the previous April samplings. The dominant taxa in each of the three April samplings at these Stations included Achnanthes minutissima, Navicula pelliculosa, and Surirella ovata, however, no clear trends in algal species composition, abundance or organics weights are apparent from the three April collections.

At Stations 27 and 29 in the White River, total mean cell densities were somewhat lower in April 1978 than in the April samplings in 1975 or 1976 (Table 4-5). The mean organic weights were also lower in April 1978 than in previous samplings. The dominant taxa at these two stations in April 1978 included Gomphonema olivaceum, Navicula cryptocephala, and Nitzschia dissipata. No trends are apparent in the April to April comparisons of algal species composition, densities, or organic weights at these White River Stations.

In summary, based upon April to April comparisons, no trends were evident in algal species composition, density, or organic weights at any of the sampling stations except at Station 13. The lower mean cell densities and organic weights of algae at Station 13 were likely the result of the scouring action of increased stream flows in Corral Gulch.

B. Benthos

1. Objectives

The objectives of the benthos (macroinvertebrate) studies are to assess the effects of site development on benthos communities. Benthos studies are included in the RBOSC MDP monitoring program because benthic macroinvertebrates constitute the major component of the secondary trophic level in aquatic ecosystems on and near Tract C-a, and because of their limited mobility and consequent susceptibility to physical and chemical changes.

2. Methods

The methods followed for collecting these data were described in RBOSC MDP Monitoring Report 1 and are not repeated here.

3. Results and Discussion

Benthic taxa observed during the April 1978 RBOSC MDP aquatic sampling program are listed in Appendix 4-4.1; densities for April 1978 are presented in Appendix 4-4.2. Macroinvertebrate densities of the common taxa from the three April samplings are presented in Table 4-7. The macroinvertebrate densities were generally lower in April 1978 (with the exception of Station 27) than in previous April sampling. Station 13 showed a decided decrease in macroinvertebrate numbers and diversity in 1978. This was probably caused by substrate alterations which resulted from increased flows during dewatering tests which began two months prior to the benthic sampling. Field observations at Station 13 showed a constantly shifting substrate, with pebbles up to 3 cm in diameter being washed downstream.

Table 4-7. Comparison of Most Abundant Benthic Macroinvertebrate Taxa Observed During RBOSC Aquatic MDP Studies (April 1978) and RBOSC Aquatic Baseline Studies (April 1975 and 1976). (Organisms/m^2)

Taxa	Year			
	1975	1976	1977	1978
STATION 13				
Nematoda	241	24	9	42
Oligochaeta	96	18	1,720	150
Acari	-	-	18	-
Baetidae	440	115	9	-
Baetis sp	2,245	24	54	-
Coenagrionidae		6	-	-
Isoperla sp	91	24	887	-
Dytiscidae	-	-	55	6
Ormosia sp	-	6	-	-
Dicranota sp	-	-	18	-
Holorusia sp	-	36	-	-
Ceratopogonidae	416	18	64	12
Chironomidae	10,896	1,961	20,245	66
Empididae	-	6	45	-
Hemerodromia	60	-	-	-
STATION 14				
Nematoda	252	187	NS	-
Oligochaeta	3,405	294		994
Baetidae	15	24		-
Callibaetis	1,184	-		-
Dytiscidae	-	24		126
Ceratopogonidae	622	163		66
Chironomidae	59,836	16,531		3,270
Simuliidae	44	48		-
Clinocira	44	-		-
Limnophora aequifrons	-	24		-
STATION 20				
Nematoda	145	320	371	289
Oligochaeta	627	2,353	154	222
Acari	217	-	91	174
Collembola	-	6	-	-
Rhithrogena sp	-	-	9	-
Plecoptera	-	-	9	-
Ceratopogonidae	2,299	72	100	1,266
Chironomidae (Larvae)	5,750	1,002	2,588	3,336
Simuliidae (Larvae)	1,762	24	869	1,857
Simulium sp (pupae)	97	-	136	42
Chrysops sp	-	6	-	-
Coenagrionidae	12	-	-	-

Table 4-7. (Continued)

Taxa	1975	1976	1977	1978
		STATION 21		
		Year		
Nematoda	66	290		114
Oligochaeta	18	271		301
Acari	72	-		144
Baetidae	6	-		-
Plecoptera	6	-	NS	-
Deronectes	-	54		-
Ormosia	18	6		-
Ceratopogonidae	392	332		784
Chironomidae (Larvae)	5,279	754		2,853
Simuliidae (Larvae)	1,231	6		1,671
		STATION 27		
Nematoda	7	13		19
Oligochaeta	477	59		1,130
Baetidae	20	72		266
Heptagenia	-	-		91
Ephemerella	221	1,528		468
Tricorythodes	39	98	NS	1,696
Plecoptera	-	65		13
Isoperla	13	13		52
Hydropsychidae	-	33		65
Cheumatopsyche	-	-		39
Hydropsyche	-	39		110
Ceratopogonidae	-	-		46
Chironomidae (Larvae)	516	558		643
		STATION 29		
Nematoda	117	20	136	13
Oligochaeta	1,615	852	397	648
Baetidae	26	39	1,747	65
Baetis sp	52	13	-	195
Rhithrogena	33	260	72	110
Ephemerella sp	631	293	3,258	110
Plecoptera	-	33	733	6
Isoperla sp	91	124	752	71
Hydropsychidae	33	7	217	26
Hydropsyche sp	156	7	589	45
Ceratopogonidae	52	13	36	39
Chironomidae	1,331	46	1,166	39
Simuliidae			118	39
Acari	26	-	-	-

NS - Not sampled during the interim program.

Station 14 was again dominated by the Chironomidae and Oligochaeta. It is continually subjected to large fluctuations in water levels and flow which affect the benthic community.

The Yellow Creek stations (20 and 21) appear to have changed very little over the three year period. The diversity remains relatively low while the densities remain high. Five major groups: the Nematoda, Oligochaeta, Ciratopogonidae, Chironomidae, and Simuludae have dominated Yellow Creek over the study period with the few fluctuations in density occurring among the Diptira.

Little change in species composition was observed in April 1978 at the White River stations from baseline years. An interesting density fluctuation among the Chironomidae at Station 29 is apparent over the four sampling periods, however the densities remained quite stable at nearby Station 27. These fluctuations may be due to physical changes with corresponding velocity changes that will cause fluctuations in numbers. A depositional area will show increases in oligochaeta and erosional areas will show increased in certain other groups. The White River is not static, and physical appearance changes rapidly in regards to erosion versus deposition.

With the exception of Station 13 the benthic macroinvertebrate community of the study area has remained relatively stable during the previous three years. The rapid change in substrate condition at Station 13 due to the increased erosion and sedimentation caused by the dewatering tests most likely caused the decline in macroinvertebrate densities at this station.

SECTION 5

HYDROLOGY STUDIES

Extensive hydrology data were collected from Tract C-a during the baseline, October 1974 to September 1976, and interim, September 1976 to September 1977, Tract C-a monitoring programs. The hydrology program included studies of precipitation, surface water, and groundwater. The United States Geological Survey (USGS) operated seven gaging stations in the vicinity of Tract C-a during this period. These stations continuously and automatically monitored stream temperature, conductivity, flow and sediment load during the spring, summer and fall. During the winter, three stations were operated. The USGS also conducted extensive monthly water sampling and analysis programs at each of these stations during periods of stream flow. A more limited analysis program was conducted during the interim period.

Six springs and seeps were studied in detail during the baseline period. Velocity and water quality data gathered at these springs and seeps indicated they have their source in alluvial or shallow bedrock aquifers.

Seven alluvial aquifer monitoring holes were completed in the vicinity of Tract C-a. Three failed to produce water during drilling and did not contain water during the baseline program. Four holes had continuously measurable water levels at the onset of drilling to the end of the baseline period. Water level, pH, temperature, and conductivity were measured in the field monthly for each of these eight holes. Extensive water quality analyses were also performed on water samples taken from these holes on a monthly basis. In order to provide continuity through the interim period, a single alluvial monitor hole was selected and monitored on a quarterly basis. This hole was GS S-11.

During various pre-lease programs, two deep groundwater aquifers were identified and some of their characteristics identified. RBOSC gathered additional data during these drilling, monitoring, and pumping test programs. The results of all of these programs have shown the upper aquifer to be in and near the Mahogany Zone of the Green River Formation. Water quality of the upper aquifer was generally found to be better than that of the lower aquifers. Water level was continuously monitored in several wells in each aquifer. The data from GS 4-5 in both the upper and lower aquifers were

continuously recorded through the interim period to provide continuity with the baseline data.

Data from the Baseline and Interim Periods have been presented in Quarterly Reports 1 through 11, DDP of 1976, The Final Environmental Baseline Report, and two Interim Studies Semi-Annual Reports dated March and October 1977.

Since the Modular Development Phase (MDP) of the RBOSP operation began in September 1977, surface and groundwater parameters have been regularly monitored to detect and assess any impact of the MDP activities. MDP monitoring data from September through November 1977 were reported in the MDP Monitoring Report 1. The data collected December 1977 through May 1978 will be presented in this report.

5.1 SURFACE WATER

A. Streams

1. Objectives

The objectives of the surface water monitoring are to determine if surface water quantity and quality are affected by the Tract C-a MIS mining activities, and construction of associated facilities.

2. Methods

Surface water quantity and quality are monitored through the use of six surface water gaging stations (Figure 5-1), by the USGS.

A. (09306237) Dry Fork near west line Tract C-a
B. (09306235) Corral Gulch near west line Tract C-a
C. (09306240) Box Elder Gulch near west line Tract C-a
D. (09306242) Corral Gulch east of Tract C-a
E. (09306255) Yellow Creek near White River, Colorado
F. (09306241) "Rinky Dink" Gulch near east line Tract C-a

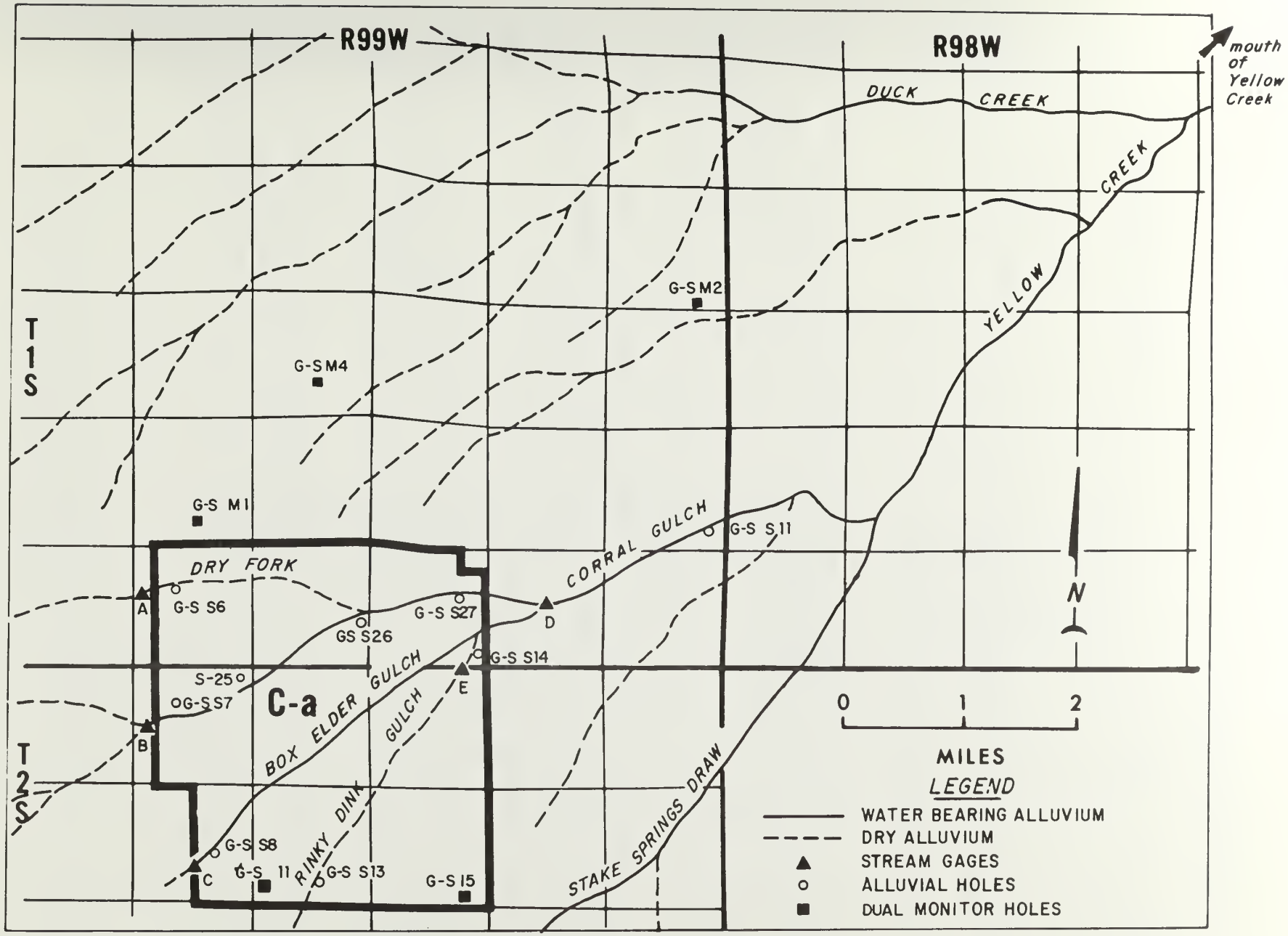


Figure 5-1. Locations of Monitoring Stations for Hydrology Studies During the MDP.

Conductivity, temperature, and flow are monitored on a continuous basis: Quarterly monitoring includes the major ions (Ca, Mg, SO_4, CL, K, HCO_3, CO_2) and sodium, fluoride, silica, DOC, pH, and alkalinity.

Semi-annual analyses are performed on 72 water quality parameters at six surface water gaging stations and surface water impoundments where water is present. (Table 5-1).

3. Results and Discussions

Tables 5-2 through 5-4 show comparisons of water quality data for stations 09306240--Box Elder Gulch near west line Tract C-a, 09306255--Yellow Creek near White River, Colorado, and 09306242--Corral Gulch each of Tract C-a for baseline and MDP periods. No flow was reported for Dry Fork, Corral Gulch near West line Tract C-a, and "Rinky Dink" Gulch near east line Tract C-a.

Most values reported fall within baseline ranges. However, the April 5 sample at Corral Gulch shows pH somewhat low and silica and sulfate somewhat high. Specific conductance at Box Elder Gulch was high on April 5 at 580 ppm compared to the baseline high of 400 ppm (Table 5-2 and 5-4).

High and low values from continuously collected data are shown in Tables 5-5 through 5-7. All data reported remains within or close to the baseline limits, except minimum values for conductivity at 09306240 and 09306242.

All data reported by the USGS for the stream gaging stations are contained in Appendix 5-2. DOC Fractionation data for Box Elder, Corral Gulch near West line tract C-a, Corral Gulch near east line tract C-a, and Yellow Creek are presented in Appendix 5-2.3.

Table 5-1. Water Chemistry Parameters Analyzed Semi-Annually at the Surface Water Gaging Stations and Impoundments During RBOSC MDP Activities.

Standard Wet Chemical Analysis[1]

Bromide
Alkalinity
Biological Oxygen Demand
Dissolved Organic Carbon
Boron
Selenium
Calcium
Conductance
Fluoride
Magnesium

Potassium
Silica
Sodium
Chemical Oxygen Demand
Fecal Coliform
Pesticides
Nitrogen, Ammonia
Total Coliform
Strontium
Cyanide

MBAS
Oil & Grease
Sulfate
Ammonia
Bicarbonate
Carbonate
Chloride
Color
Sodium Adsorption Ratio
Dissolved Solids

Kjeldahl Nitrogen
Nitrate Plus Nitrite
Odor
Dissolved Phosphate
Turbidity
Dissolved Oxygen
Phenols
Sulfide
pH
Temperature

Radioactivity

Gross Alpha
if 4 pci/l
then Ra^{226}
Natural Uranium

Gross Beta
if 100 pci/l
then Sr^{90}
Ce^{137}

Total Phosphate
Ortho Phosphate
Suspended Organic Carbon
Aluminum
Arsenic
Cadmium
Chromium
Selenium
Mercury
Zinc
Iron
Lead

Spectrographic Analysis

Molybdenum
Lithium
Mangenese
Barium
Beryllium
Germanium
Gallium
Nickel
Titanium
Vanadium
Zirconium
Copper

[1]To EPA or detectable limits already established.

Table 5-2. Results of Water Analysis located at USGS Stream Gaging Station (09306242), Corral Gulch East of Tract C-a.

Parameter	December 29 1977	January 20 1978	April 5 1978	Baseline Data High	Baseline Data Low	Baseline Data Geo. Mean	No. of Analyses
Temperature (C)	9	12	12	22.0	3.0	11.47	65
Specific Conductance	1200	1200	1600	1725	797	1231.54	59
Discharge (cfs)	0.22	2.3	2.2	0.74	0	-	--
Alkalinity	420	450	400	739	268	403.86	58
pH	7.7	8.1	7.0	8.9	7.10	7.88	58
Fluoride	0.5	0.9	0.4	10.0	0.2	0.49	58
Sodium	130	150	70	300.0	51.0	109.15	58
Silica	21	32	8.2	24.0	13.0	21.10	58
Dissolved Organic Carbon	5.6	7.2	12.4	14.0	1.7	8.12	10
Major Ions							
Ca	91.0	67.0	57.0	110.0	55.0	85.56	58
Mg	74	75	99	71.0	45.0	62.04	58
SO	330	320	440	360.0	160.0	288.77	58
Cl	12	8.9	14	19.0	5.9	9.78	58
K	1.7	2.3	2.0	3.0	0.7	1.59	58
HCO	510	550	490	901.0	327.0	492.0	58
NO Nitrite	-	-	0.1	0.1	0.01	0.02	21
NO Nitrate	-	-	7.2	3.0	0.93	1.22	20

Table 5-3. Results of Water Analysis located at USGS Stream Gaging station (09306255), Yellow Creek near White River, Colorado.

Parameter	December 28 1977	March 27 1978	Baseline Data High	Low	Geo Mean	No. of Analyses
Temperature (°C)	0.5	21.0	28.0	0	12.29	45
Specific Conductance	4250	3800	5000.0	2410.0	3689.72	45
Discharge (cfs)	0.93	1.8				
Alkalinity	1720	1600	1670	894	1443.1	43
pH	8.4	8.9	10.10	8.0	8.55	44
Fluoride	1.4	2.2	3.0	1.2	2.26	44
Sodium	900.0	830.0	940.0	500.0	778.28	45
Silica	13.0	12.0	20.0	0.3	10.34	45
Dissolved Organic Carbon	7.5	8.7	43.0	4.3	8.97	12
Major Ions						
Ca	35.0	35.0	130.0	7.0	31.81	45
Mg	120.0	140.0	140.0	50.0	108.24	45
SO_4	570.0	580.0	750.0	400.0	556.14	45
Cl	170.0	120.0	200.0	93.0	125.91	45
K	5.0	5.2	7.4	3.5	4.14	45
HCO_3	1910	1830	1990.0	596.0	1513.94	43
NO_2 Nitrite	-	0.62	0.23	<0.01	0.05	22
NO_3 Nitrate	-		12.0	0.04	4.8	22

Table 5-4. Results of Water Analysis Located at USGS Stream Gaging Station (09306240), Box Elder Gulch near West line Tract C-a.

Parameter	March 22 1978	Baseline Data			No. of Analyses
		High	Low	Geo. Mean	
Temperature (^{o}C)	0.5	27.5	3.0	13.97	13
Specific Conductance	580	400.0	160.0	845.16	12
Discharge (cfs)	0.55				
Alkalinity	190	372	74	283	12
pH	6.8	9.0	7.7	8.04	11
Fluoride	0.2	0.7	0.1	0.33	12
Sodium	44	93	2.7	42.9	12
Silica	9.1	24	3.2	19.28	12
Dissolved Organic Carbon	13	34	4.2	9.67	4
Major Ions					
Ca	53	86	17	66.35	12
Mg	24	61	5.4	39.43	12
SO_4	120	280	5.5	125.57	12
Cl	4.7	8.2	3.0	5.57	12
K	4.3	11.0	0.7	1.21	12
HCO_3	230.0	453.0	90.0	338.38	12
NO_2	-	0.03	<0.01	0.02	4
NO_3	-	4.4	3.9	4.12	4

Table 5-5. High and Low Discharge Values at Surface Water Gaging Stations, Tract C-a.

Gaging Station	Discharge (Dec.77-May 78) High	Low	Baseline Discharge (cfs) High	Low	Arith Mean	Standard Deviation
09306235 Corral Gulch near West Line Tract C-a	0.50	0	0.74	0	0.18	0.17
09306240 Boy Elder Gulch near West Line Tract C-a	2.08	0	2.9	0	0.20	0.59
09306242 Corral Gulch East of Tract C-a	5.5	0.14	5.6	0.06	0.73	0.57
09306255 Yellow Creek near White River, CO	2.65	0.40	13.0	0.23	1.87	1.3

Date reported through June 4, 1978.

NOTE: No flow recorded at station 09306237 and 09306241

Table 5-6. High and Low Conductivity Values at Surface Water Gaging Stations, Tract C-a.

Gaging Station	Conductivity (December 1977 - May 1978)		Baseline Conductivity			
	High	Low	High	Low	Arth. Mean	Standard Deviation
09306235 Corral Gulch near West line Tract C-a	1270	230	1330	752	1043	115
09306240 Box Elder Gulch near West line Tract C-a	968	99	891	595	775	73.4
09306242 Corral Gulch East of Tract C-a	2070	97	2050	761	1272	187
09306255 Yellow Creek near White River, CO	5380	1888	5080	1410	3532	568

Data Reported through June 4, 1978

NOTE: No flow recorded at stations 09306237 and 09306241

Table 5-7. High and Low Temperature Values at Surface Water Gaging Stations, Tract C-a.

Gaging Station	Temperature (°C) (December 1977 - May 1978) High	Low	Baseline Temperature High	Low	Arith Mean	Standard Deviation
09306235 Corral Gulch near West line Tract C-a	24.0	2.5	33.1	0.5	14.8	5.97
09306240 Box Elder Gulch near West line Tract C-a	24.0	0	17.5	5.5	11.3	2.51
09306242 Corral Gulch East of Tract C-a	24.5	0	22.0	5.0	10.2	2.52
09306255 Yellow Creek near White River, CO	24.3	0	25.0	0.0	12.1	6.67

Data reported through June 4, 1978.

NOTE: No flow recorded at stations 09306237 and 09306241

B. Springs and Seeps

1. Objectives

The objective of monitoring and observing major springs and seeps during the MDP is to determine if flow and conductivity are affected by dewatering and reinjection.

2. Methods

Flow, conductivity, temperature, dissolved organic carbon, and pH are measured quarterly at six major springs and seeps located on and around Tract C-a (Figure 5-2). The rationale for measuring flows from springs and seeps is based upon analysis of two years of baseline data, which indicated that four of the springs and seeps studied in detail are hydrologically connected to the upper oil shale aquifer.

Perturbations to the water quality of springs and seeps will be detected by analysis of the conductivity data. The rationale for using conductivity as a detector parameter is based on a high correlation with changes in other water quality parameters as determined during the statistical analysis of data collected during baseline monitoring. At each of the six springs and seeps to be studied during the MDP, conductivity measurements were made six times a year during baseline. Therefore, a comparison can be made between future conductivity readings and baseline data to verify that they are not greater than 20 percent more than the maximum nor less than 20 percent below the minimum rating during either the snowmelt runoff season or the base flow season. These seasons, as determined from baseline data, appear to run from February 1 until July 1, and from July 1 until January 31 for the snowmelt runoff and base flow seasons, respectively.

3. Results and Discussions

One quarterly measurement has been made since MDP Report No. 1. These measurements are presented on Table 5-8. Maximum and minimum baseline data are

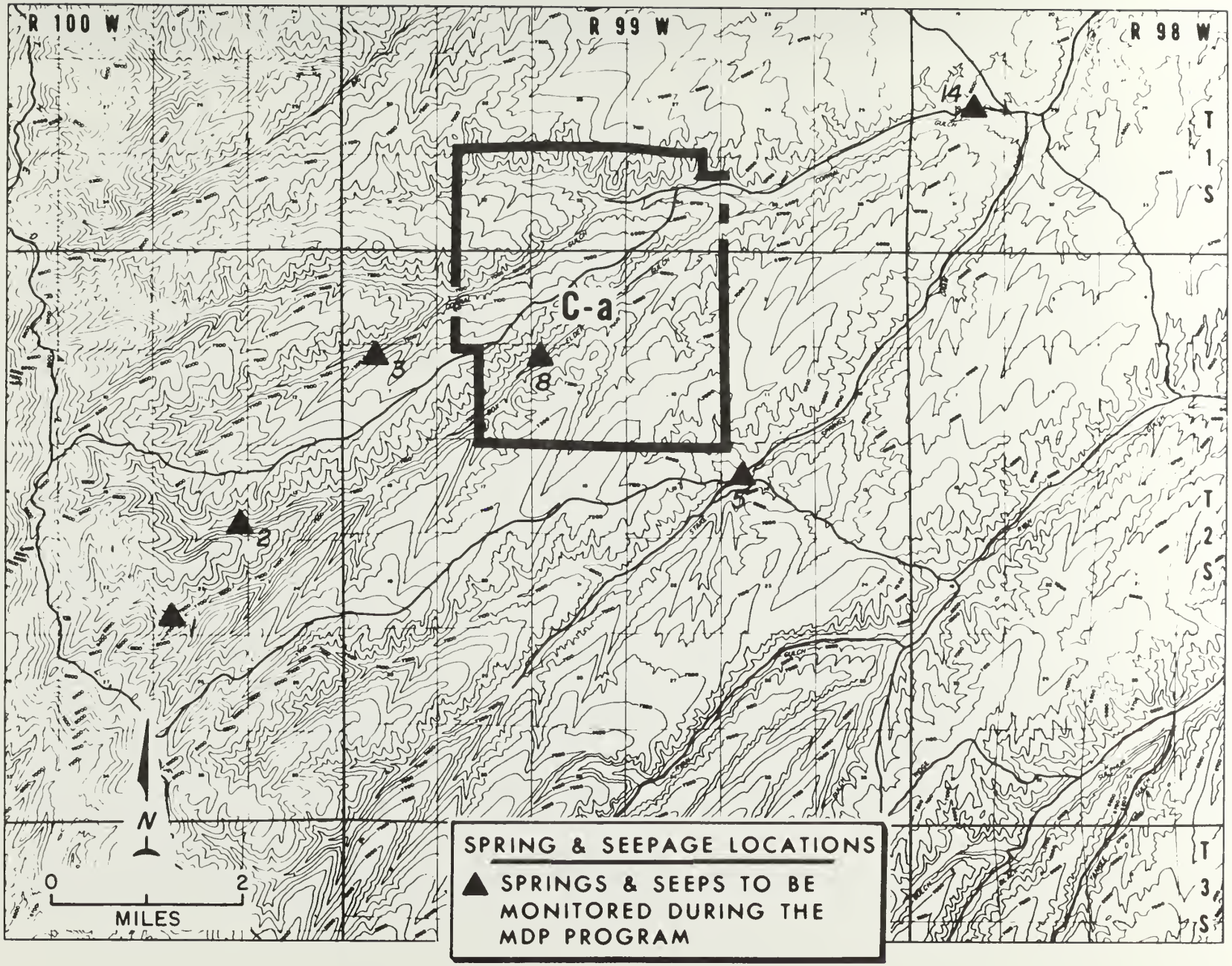


Figure 5-2. Springs and Seeps to be Monitored During the MDP.

Table 5-8. Temperature, Flow, Conductivity, and pH Data for Springs and Seeps in the Vicinity of Tract C-a.

	Temperature °C			Specific Conductance			Flow	pH
	Baseline		April	Baseline		April	April	April
	Min.	Max	'78	Min.	Max	'78	'78	'78
1. Cathedral Bluffs	1	19		825	950			
2. Spruce Gulch	7	11		1000	1200			
3. Maverick Spring	5	21		850	1300			
5. Stake Springs Draw	3	22	11	1300	1500	1250	0.26	7.0
8. Box Elder Gulch	5	12	12	850	1100	1000	70.4	6.8
14. 84 Ranch	0	19	12	1550	2000	875	0.3	6.8

Data for April 1978 on #1, 2, and 3 is not available due to inaccessibility during that time of year.

presented for comparison with the data collected in April 1978. Cathedral Bluffs (#1), Spruce Gulch (#2), Maverick Springs (#3) were inaccessable in April 1978 so are not included in the table.

Note that the specific conductance for 84 Ranch and Stake Springs dropped below the baseline minimum. The specific conductance at 84 Ranch fell more than 20 percent below the baseline minimum. This suggests an improvement over the basline water quality. Initial DOC Fractionation tests were run for all six Springs and Seeps. The results are contained in the Appendix 5-2.3.

5.2 GROUNDWATER

A. Alluvial Aquifers

1. Objectives

The objectives of monitoring the alluvial aquifers are to determine if conditions have changed since the baseline data were collected and to detect impacts caused by accidental oil spills or relases of dewatering water into the alluvial aquifers.

2. Methods

During the baseline period, a total of seven shallow alluvial monitor holes was drilled and monitored. The monitoring of six holes plus two new alluvial holes (Figure 5-1) will meet the objectives of the MDP Environmental Hydrology Monitoring Program.

Water level is measured continuously at GS S-26, GS S-27, GS S-11, and GS S-7 by water level recorders. In addition, samples are collected and analyzed quarterly for alkalinity, pH, sodium, silica, fluoride, conductivity, temperature, and the other major ions (Ca, Mg, NO_2+NO_3, SO_4,Cl,K,HCO_3). The alluvial holes are sampled and analyzed for all baseline constituents (listed below) twice a year.

Water Level	Alkalinity	Cyanide
Selenium	Silica	Chemical Oxygen Demand
Aluminum	Dissolved Solids	Sodium
Arsenic	Germanium*	Strontium
Barium*	Gallium*	Sulfate
Beryllium*	Fluoride	Sulfide
Bismuth*	Iron	Titanium*
Bicarbonate	Lead	Vanadium*
Bromide	Lithium*	Zirconium*
Boron	Magnesium	Zinc
Dissolved Organic Carbon	Maganese*	Color
Calcium	Mercury	Odor
Carbonate	Molydenum*	pH
Cadmium	Nickel*	Temperature
Chloride	Nitrate plus Nitrite	Conductance
Chromium	Phenols	Radioactivity
Copper*	Dissolved Phosphate	Gross Alpha if >4 pci/l then Ra^{226} Natural Uranium
Oil and Grease	Potassium	Gross Beta if >100 pci/l then Sr^{90} Ce^{137}

* By spectrographic methods only, others by standard wet chemical methods (or A.A.) to EPA or detectable limits already established.

If increased concentrations of dissolved organic carbon or oil and grease are detected over a period of time, then analyses will determine the possible source. These analyses can determine the type of material, i.e., No. 2 diesel fuel, unleaded gasoline, raw shale oil, etc. Once the specific oil and grease product is known, the source will be determined and corrected. The effect of the leak or spill will be mitigated.

One of the new alluvial holes, GS S-26, is located downstream from the proposed mine shaft retention pond, and the second new alluvial hole, GS S-27, is located on Corral Gulch downstream from all surface disturbances. (Figure 5-1). These two new holes were completed according to methods outlined by the AOSS. A DOC fractionation was performed for these holes following their completion and will be repeated if DOC values exceed the baseline mean by four times. GS S-14 was monitored during baseline and monitoring of this hole will continue to establish continuity between baseline and development.

As other possible inputs to a hydrologic system are known, these may be added in the monitoring program. Additional knowledge of possible inputs will be gained during the early portion of the MDP.

3. Results and Discussion

Water quality data for alluvial wells GS S-7, GS S-11, GS S-24, and GS S-27 are presented in Tables 5-9 through 5-12, along with corresponding baseline data for comparison purposes. GS S-24 was not monitored during the baseline period, and so has no baseline comparison. GS S-6, GS S-13, GS S-14, GS S-26, and GS S-27A were all dry at the time of the quarterly sampling. GS S-8 had too little water to sample.

Concentrations of most parameters fall within baseline limits. An exception is silica, which is slightly lower than baseline minimum for each of the wells reported.

Figures 5-3 through 5-10 show water levels in the alluvial holes. Water levels are generally lower in spring 1978 than they were in the same season of 1976.

Table 5.9. Water Quality of Alluvial Aquifer Hole GS S-7 for MDP and Baseline, RBOSC.

Parameter	April 5, '78	Baseline High	Baseline Low	Baseline Geo. Mean
Temperature	10.5(3/77)	11.28	6.11	--
Specific Conductance	1160.0(3/17)	1440	990	--
Water Level	25.62	--	---	--
Alkalinity	355	880	310	383
pH	6.8(3/17)	7.2	6.0	6.32
Fluoride	0.4	0.7	0.1	0.26
Sodium	160	350	66	151.1
Silica	9.6	41.0	16.0	29.2
Dissolved Organic Carbon	12.5	292	2.0	18.7
Major Ions				
Ca	52	210	39	96.4
Mg	57	145	3.7	57.04
SO_4	325	720	150	297
Cl	2.7	41	1.3	12.8
K	1.7	14	1.0	3.66
HCO_3	435	680	360	458.7
NO_2	0.01	--	---	--
NO_3	2.7	165	0.1	3.9

Table 5-10. Water Quality of Alluvial Aquifer Hole GS S-11 for MDP and Baseline, RBOSC.

Parameter	April 5, '78	Baseline		
		High	Low	Geo. Mean
Temperature	9.5	13.50	883	---
Specific Conductance	1700	2220	1560	---
Water Level	48.65	---	---	---
Alkalinity	495	880	310	383
pH	6.4	7.2	6.0	6.32
Fluoride	0.4	0.7	0.1	0.26
Sodium	260	350	66	151.1
Silica	11	41.0	16.0	29.2
Dissolved Organic Carbon	10.2	292	2.0	18.7
Major Ions				
Ca	64	210	39	96.4
Mg	125	145	3.7	57.04
SO_4	650	720	150	297
Cl	19	41	1.3	12.8
K	1.7	14	1.0	3.66
HCO_3	605	680	360	458.7
NO_2	0.01	---	---	---
NO_3	0.2	165	0.1	3.9

Table 5-11. Water Quality of Alluvial Aquifer Hole GS S-24 for MDP, RBOSC

Parameter	March 10, 1978	April 5, 1978
Temperature	6.5	
Specific Conductance	1750	
Water Level	12.16	
Alkalinity	-----	-----
pH	6.8	
Fluoride	0.4	0.4
Sodium	145	205
Silica	-----	9.3
Dissolved Organic Carbon	-----	11.7
Major Ions		
Ca	84	62
Mg	98	120
SO_4	560	530
Cl	22	22
K	2.7	2.0
HCO_3	425	580
NO_2	-----	<0.01
NO_3	7.2	5.3

NOTE: GS S-24 was not monitored during the baseline period.

Table 5-12. Water Quality of Alluvial Aquifer Hole GS S-27 for MDP and Baseline, RBOSC.

Parameter	April 5, '78	Baseline		
		High	Low	Geo. Mean
Temperature	8.5	---	---	---
Specific Conductance	1500	---	---	---
Water Level	11.97	---	---	---
Alkalinity	465	880	310	383
pH	6.4	7.2	6.0	6.32
Fluoride	0.2	0.7	0.1	0.26
Sodium	200	350	66	151.1
Silica	9.5	41.0	16.0	29.2
Dissolved Organic Carbon	10.0	292	2.0	18.7
Major Ions				
Ca	84	210	39	96.4
Mg	91	145	3.7	57.04
SO	490	720	150	297
Cl	22	41	1.3	12.8
K	2.3	14	1.0	3.66
HCO	545	680	360	458.7
NO	70.01	---	---	---
NO	70.1	165	0.1	3.9

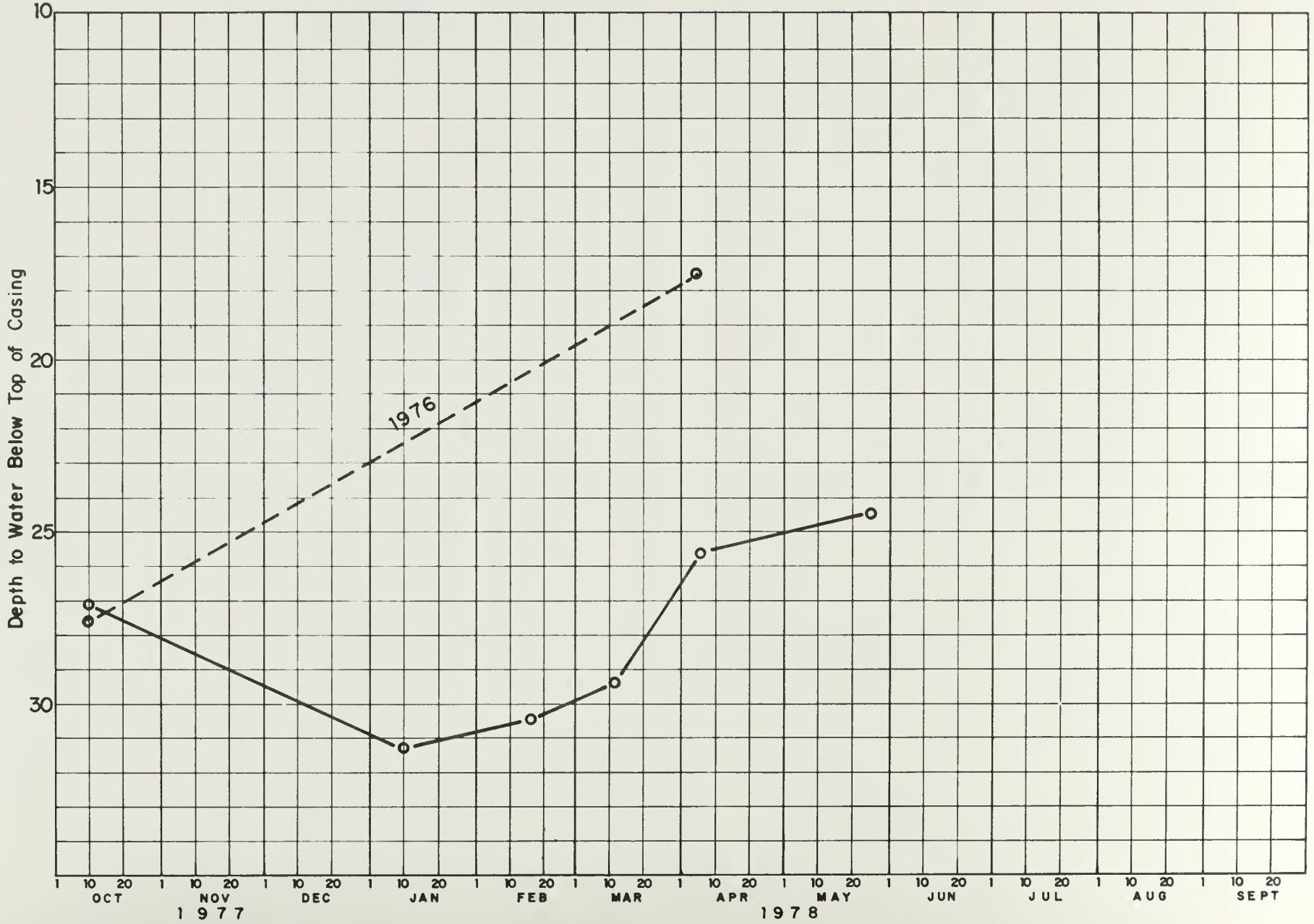


Figure 5-3. Depth to Water, Water Year 1978 with 1976 Comparison, Alluvial Hole GS S-7.

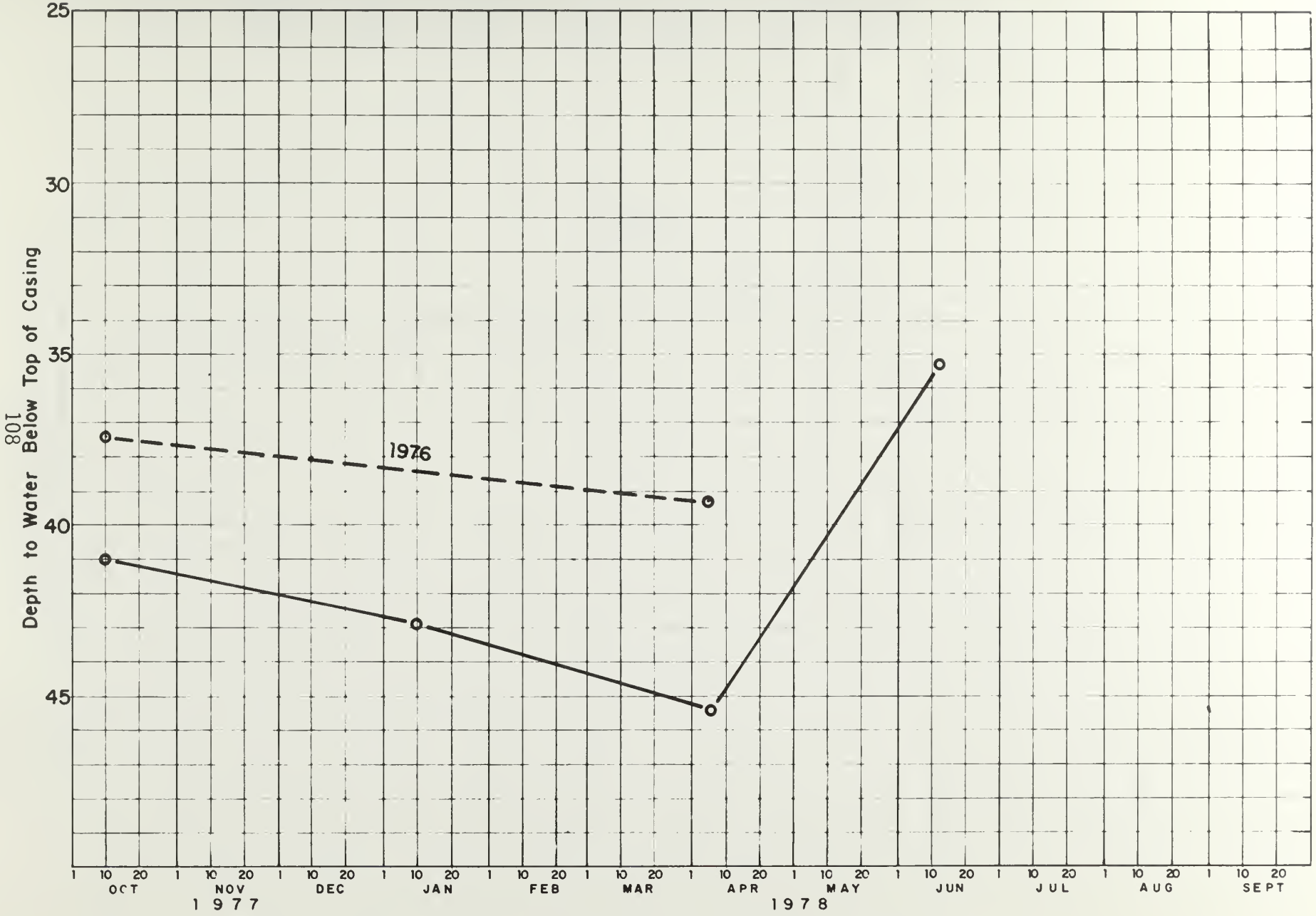


Figure 5-4. Depth to Water, Water Year 1978 with 1976 Comparison, Alluvial Hole GS S-8.

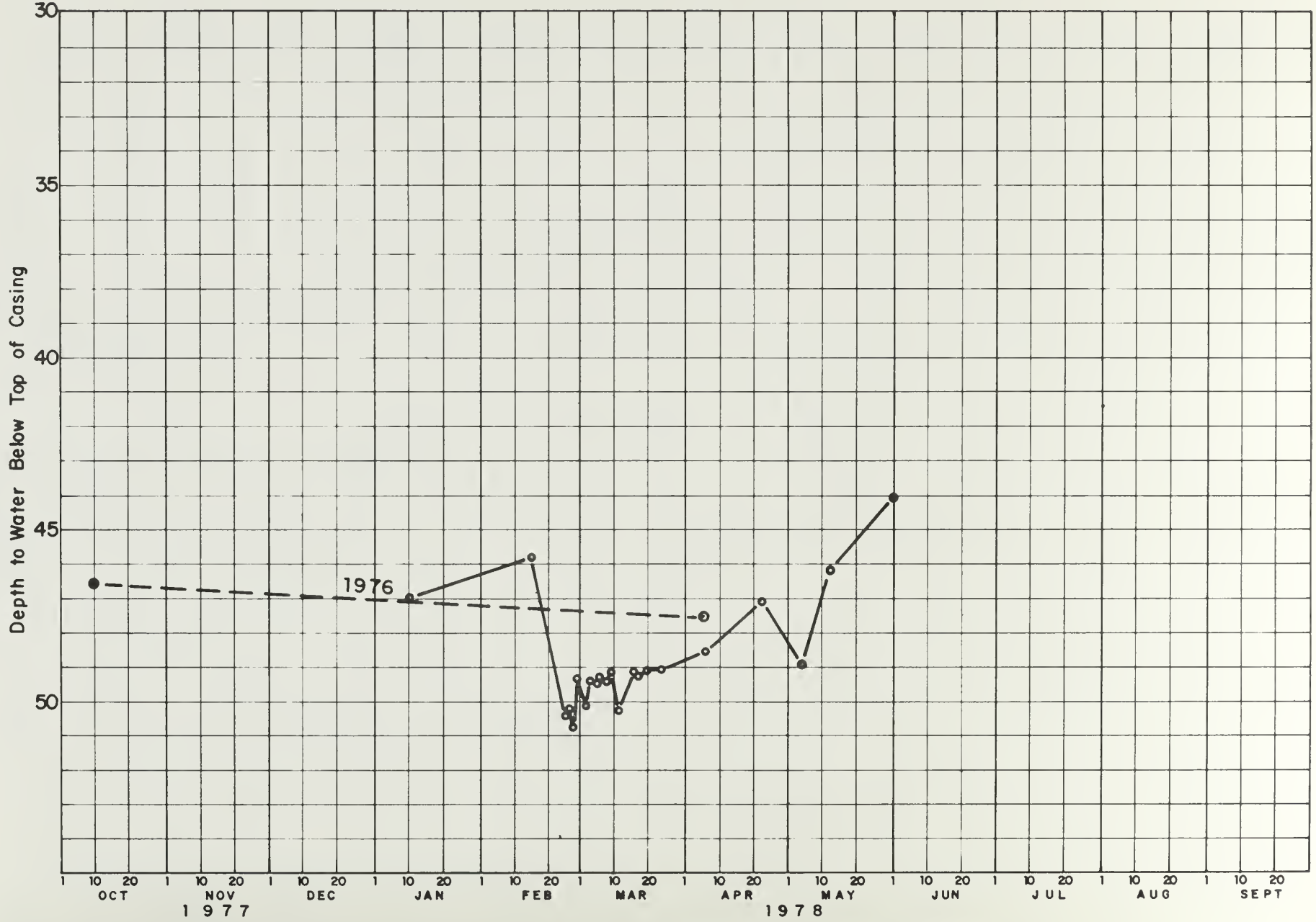


Figure 5-5. Depth to Water, Water Year 1978 with 1976 Comparison, Alluvial Hole GS S-11.

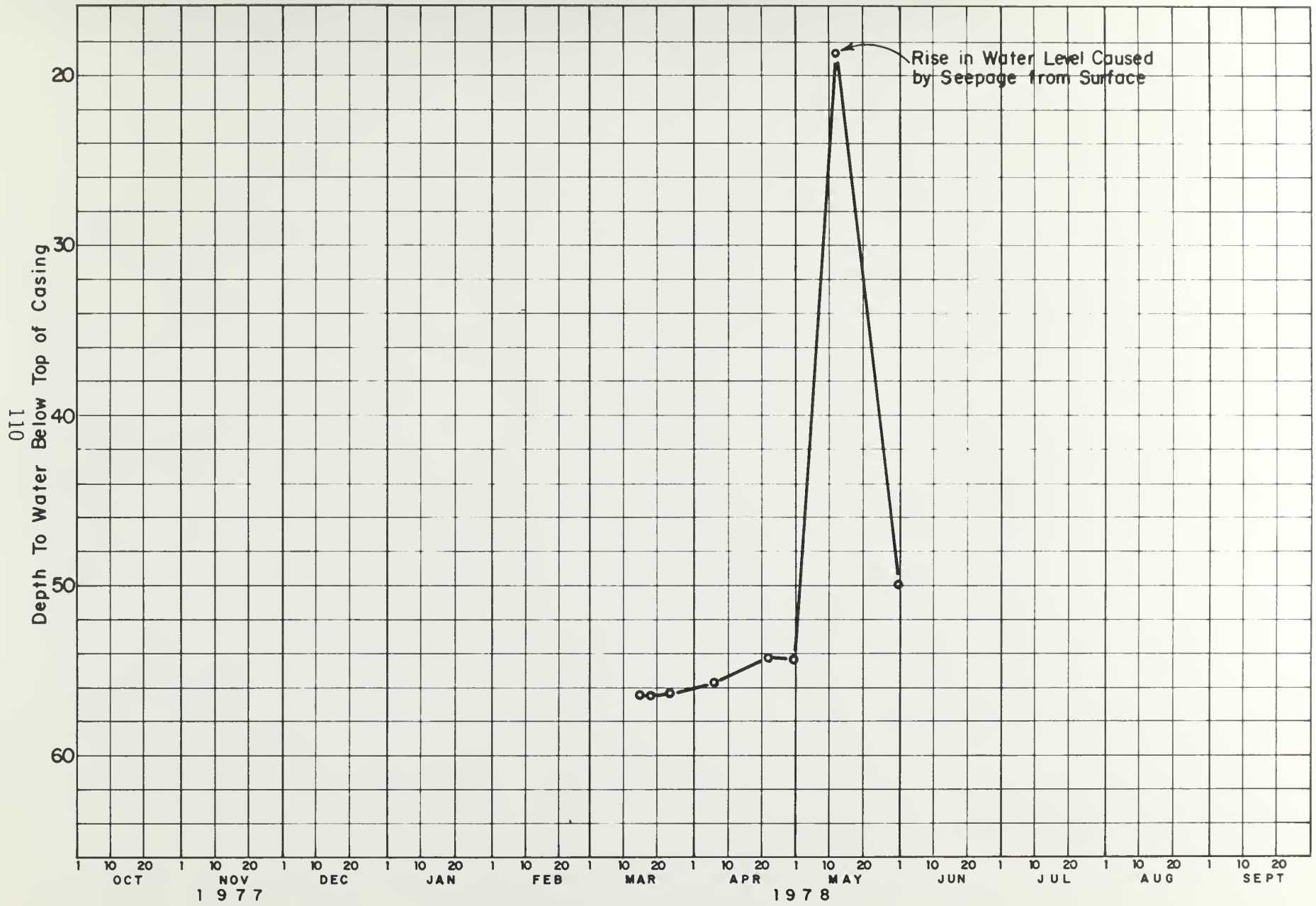

Rise in Water Level Caused by Seepage from Surface
Depth To Water Below Top of Casing
20
30
40
50
60
1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEPT
1977
1978

Figure 5-6. Depth to Water, Water Year 1978, Alluvial Hole GS S-11A (Deep).

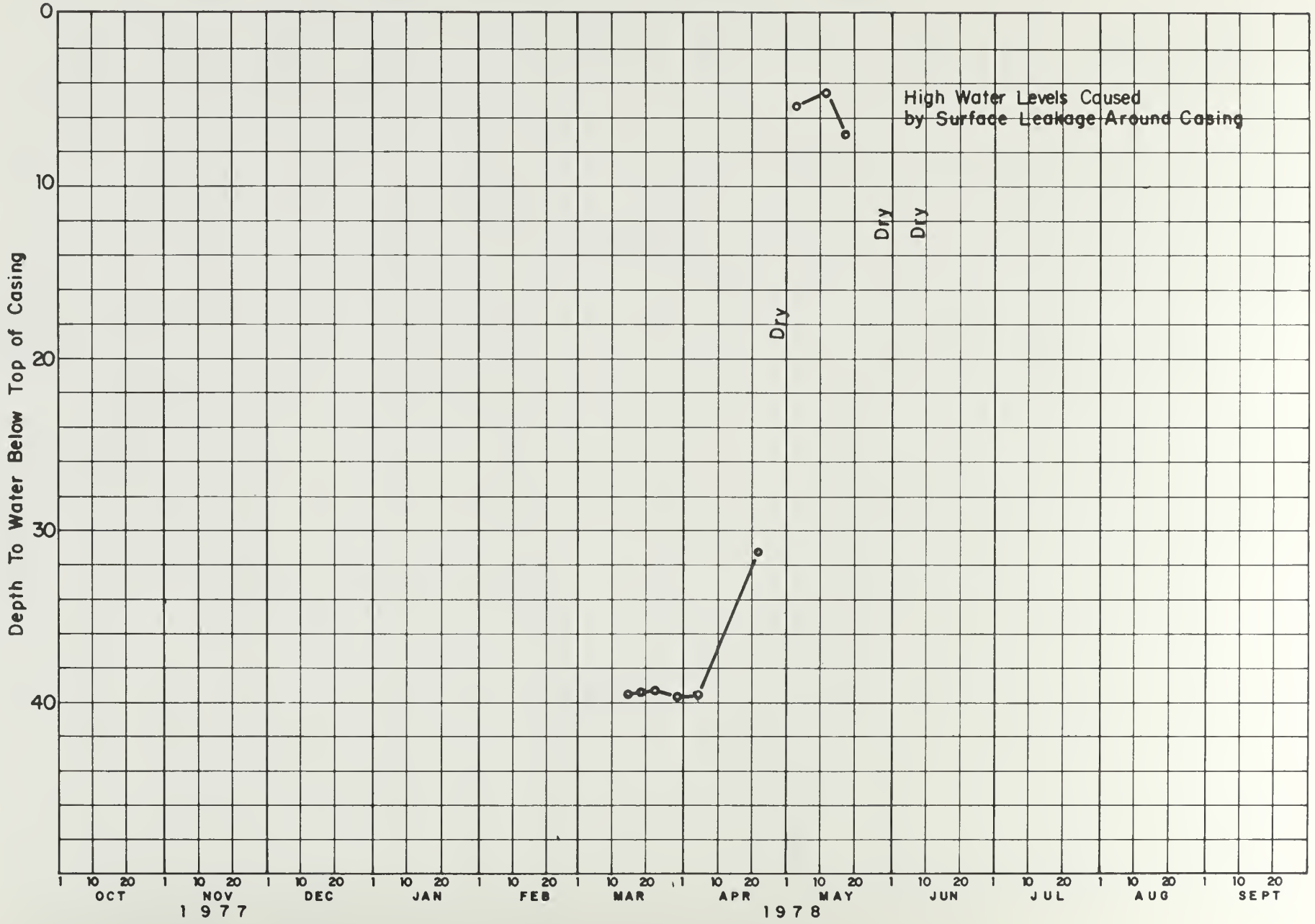

Depth To Water Below Top of Casing
0
10
20
30
40
High Water Levels Caused
by Surface Leakage Around Casing
Dry
Dry
Dry
1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEPT
1977
1978

Figure 5-7. Depth to Water, Water Year 1978, Alluvial Hole GS S-11A (Shallow).

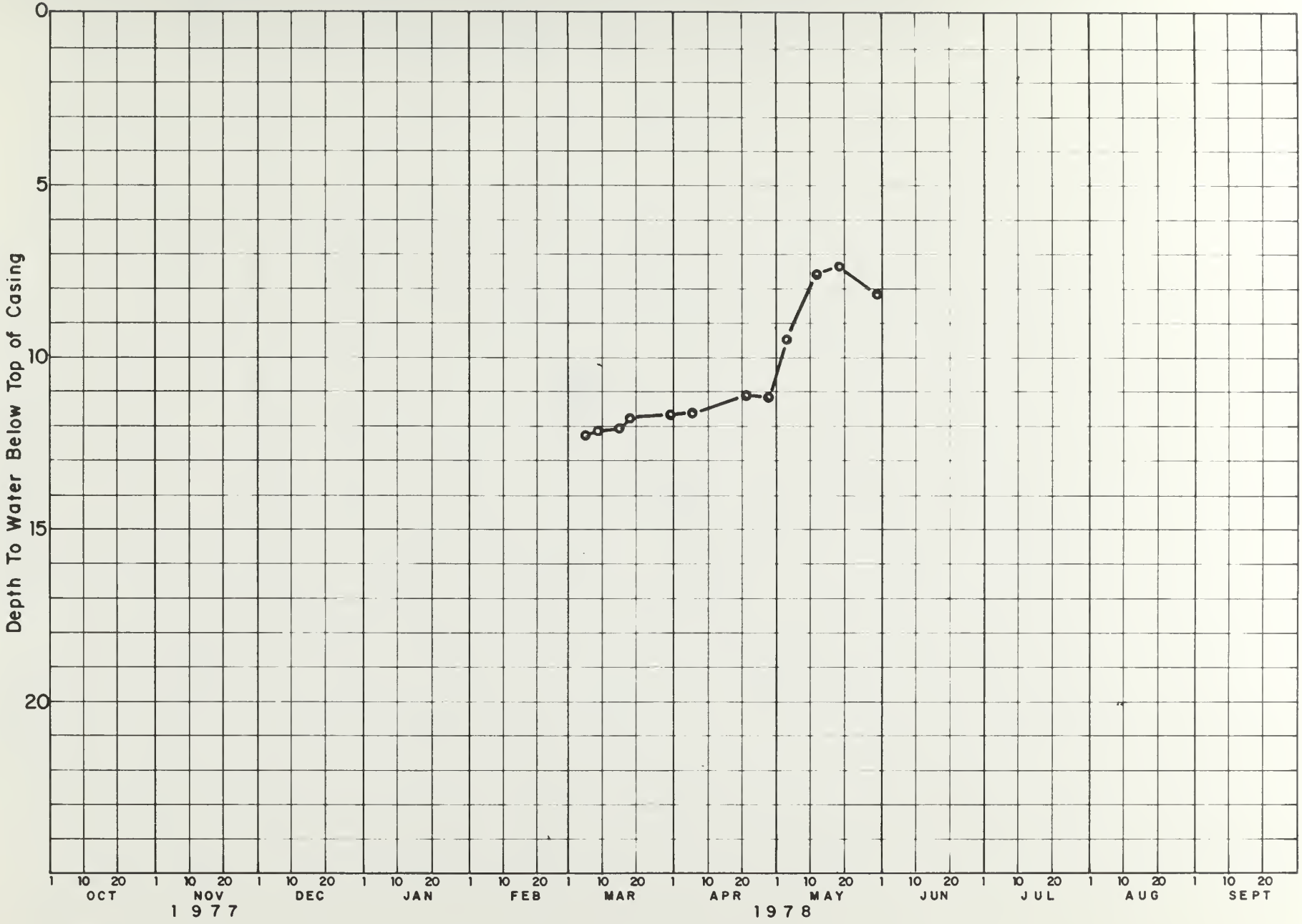


Figure 5-8. Depth to Water, Water Year 1978, Alluvial Hole GS S-24.

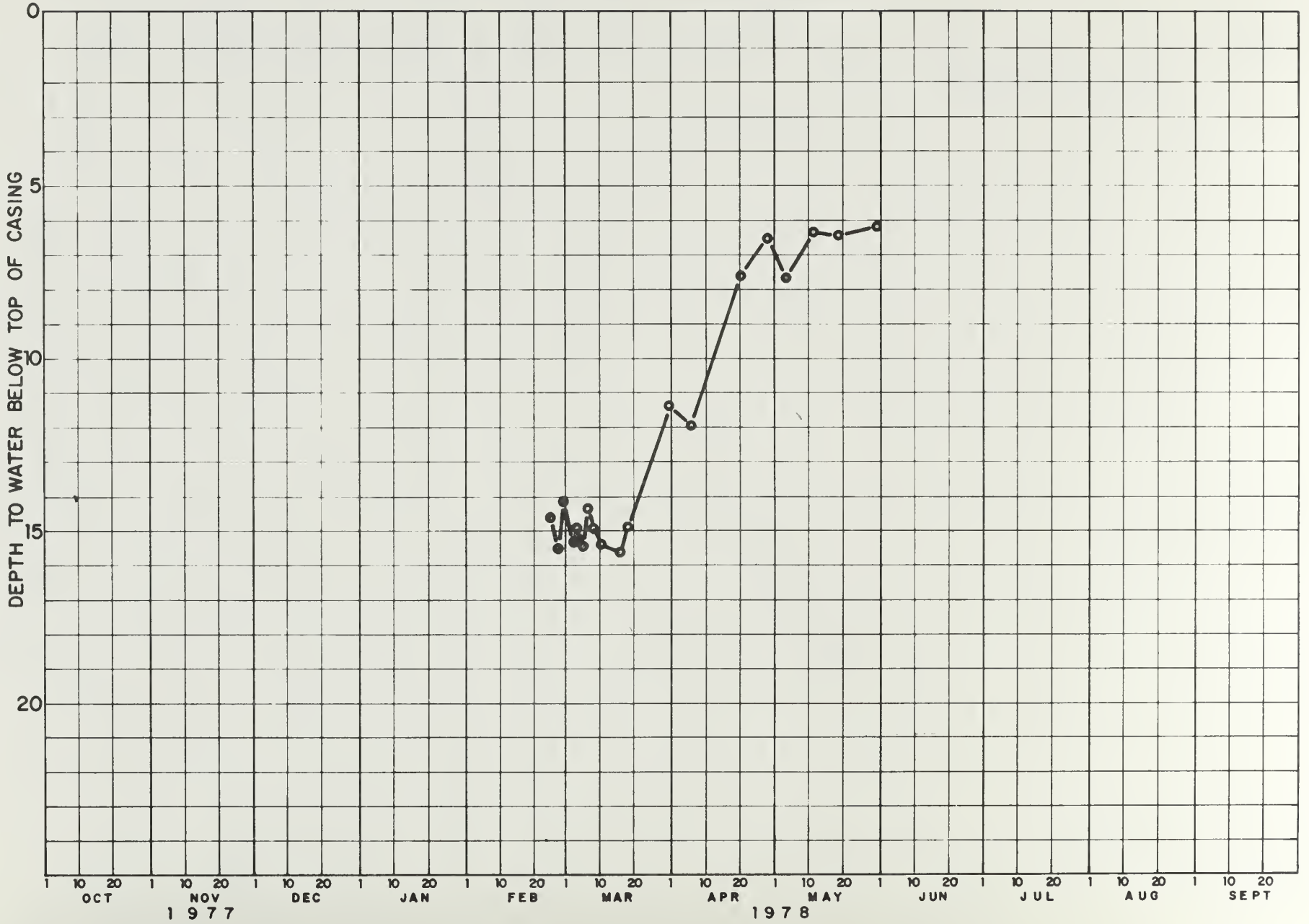


Figure 5-9. Depth to Water, Water Year 1978, Alluvial Hole GS S-27.

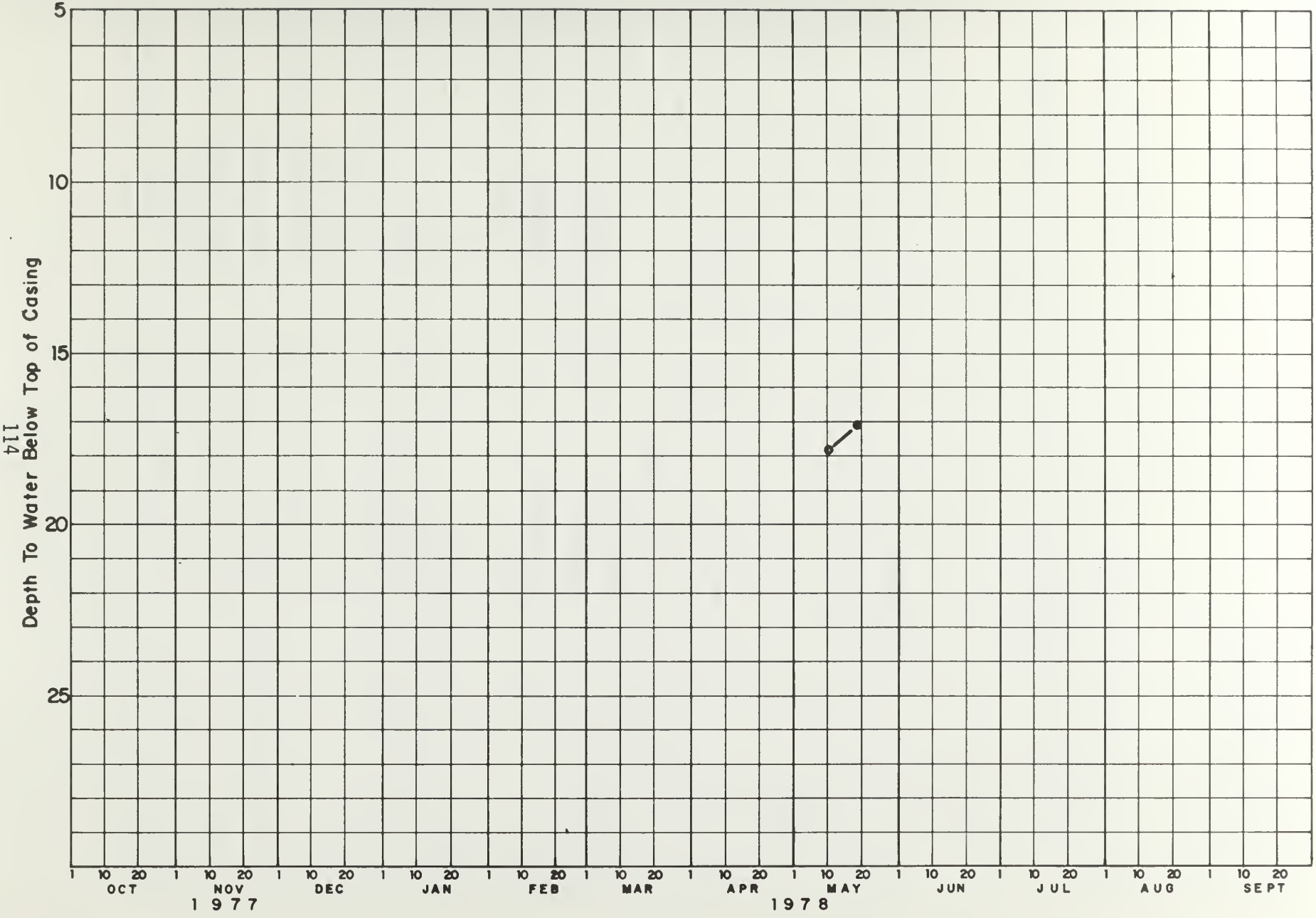


Figure 5-10. Depth to Water, Water Year 1978, Alluvial Aquifer Hole GS S-27A.

These water levels may still reflect the small amount of recharge in Spring 1977 at the time of the quarterly measurements. Late spring measurements in the continuously monitored holes show a water level rise.

DOC fractionation was performed on GS S-26 and GS S-27 on February 1978. The results are included in Appendix 5-3.2.

B. Deep Oil Shale Aquifers

1. Objectives

The purpose for this groundwater monitoring is to measure water levels in the upper aquifer and to monitor any possible changes in the water quality.

2. Methods

Water levels in the upper aquifer are continuously measured at five locations: GS M-1, GS M-2, GS M-4, GS 11 and GS 15. Annual analyses are performed on 53 water quality parameters (listed below).

Alkalinity
Aluminum
Ammonia
Arsenic
Barium*
Beryllium*
Bismuth*
Bicarbonate
Bromide
Boron
Dissolved Organic Carbon
Calcium
Carbonate
Cadmium
Germanium*
Gallium*
Fluoride
Iron
Lead
Lithium*
Magnesium
manganese*
Mercury
Molybdenum *
Nickel*
Nitrate plus Nitrite
Phenols
Dissolved Phosphate
Sulfide
Titanium*
Vanadium*
Zirconium*
Zinc
Color
Odor
pH
Temperature
Conductance
Radioactivity
Gross Alpha
if >4 pci/l
then Ra^{226}
Natural Uranium

Chloride	Potassium	Gross Beta if >100 pci/l then Sr^{90} Ce^{137}
Chromium	Selenium	
Copper*	Silica	
Cyanide	Sodium	
COD	Strontium	
Dissolved Solids	Sulfate	

*By spectrographic methods only, others by standard wet chemical (or A.A.) methods to EPA or detectable limits already established.

3. Results and Discussions

Water levels in the deep holes are shown on Figures 5-11 through 5-13. Table 5-13 shows water level readings on April 5 for both upper and lower aquifers. The data indicate little change in water level, with the exception of the water level in the lower aquifer of GS M-1, which rose sharply in January.

5.3 MDP Pump Test Monitoring

The MDP pump test began in December 1977. Total daily discharge of pumps D1, D2, D3, and D4 is shown in Figure 5-14, which was compiled from information provided by the on-site contractor. Earliest discharge data is dated March 22, 1978.

Additional monitoring during the pump test is being conducted at nine alluvial holes, three surface water gaging stations, six deep holes, and sixteen erosion and sedimentation sites. (See Figure 5-15 for location).

A. Surface Water

2. Objectives

The objectives of monitoring surface water during the pump test are to determine the impact of the pump tests on surface water quantity and quality.

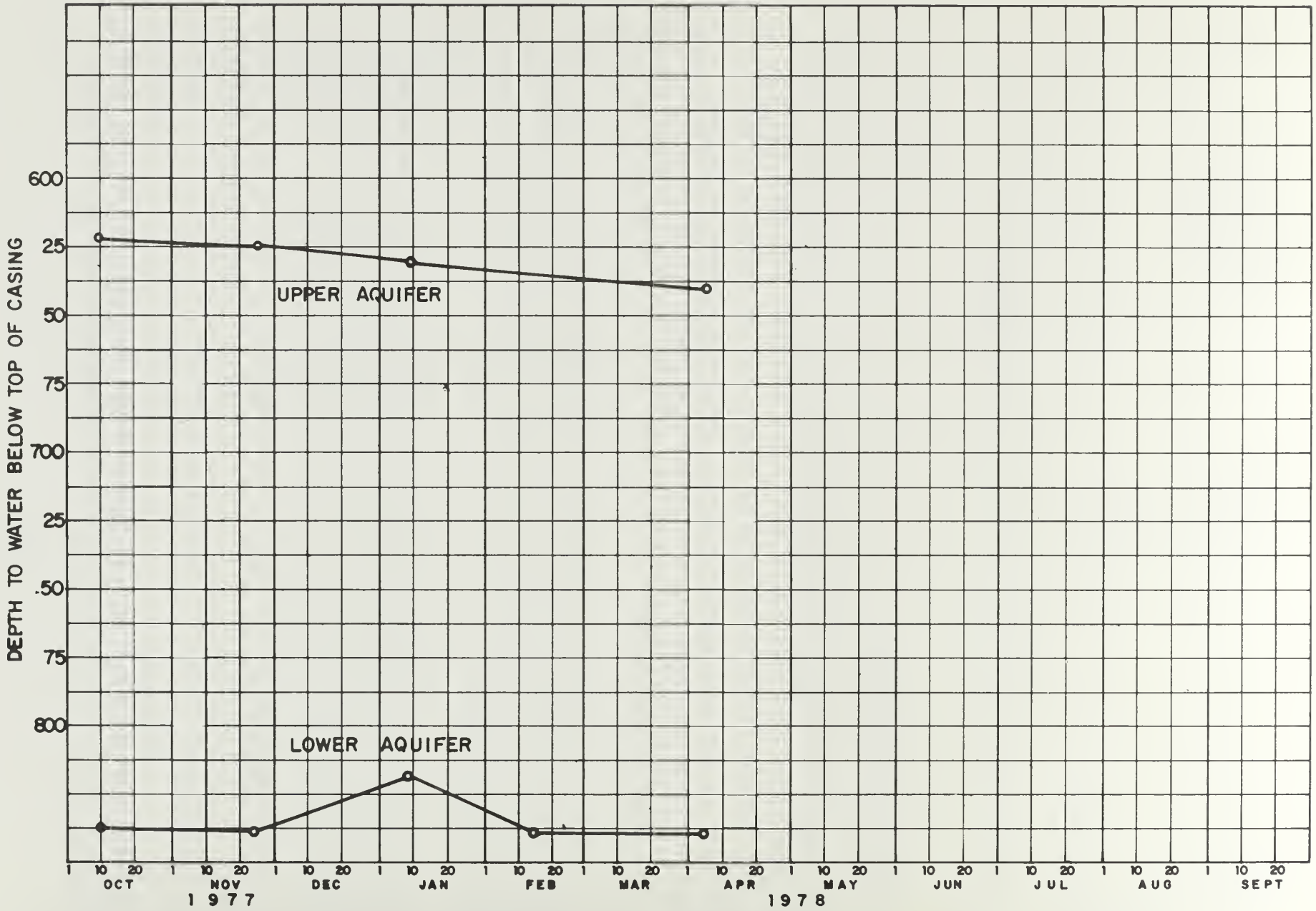

DEPTH TO WATER BELOW TOP OF CASING
600
25
50
75
700
25
50
75
800
UPPER AQUIFER
LOWER AQUIFER
1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEPT
1977
1978

Figure 5-11. Depth to Water, Water Year 1978, Deep Aquifer Hole, GS M-1, Upper and Lower Aquifer.

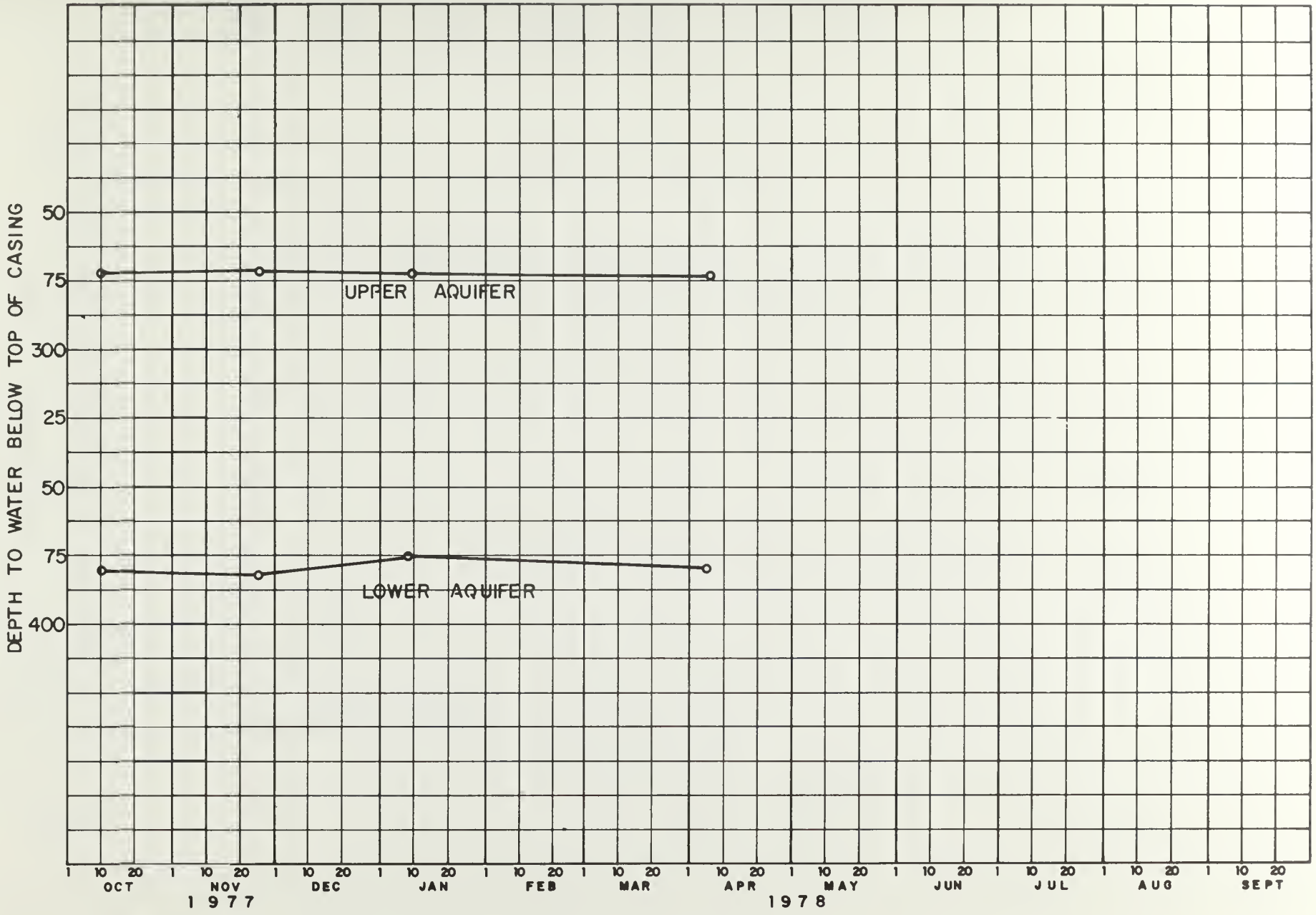

DEPTH TO WATER BELOW TOP OF CASING
50
75
300
25
50
75
400
UPPER AQUIFER
LOWER AQUIFER
1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEPT
1977
1978

Figure 5-13. Depth to Water, Water Year 1978, Deep Aquifer Hole GS 15, Upper and Lower Aquifer.

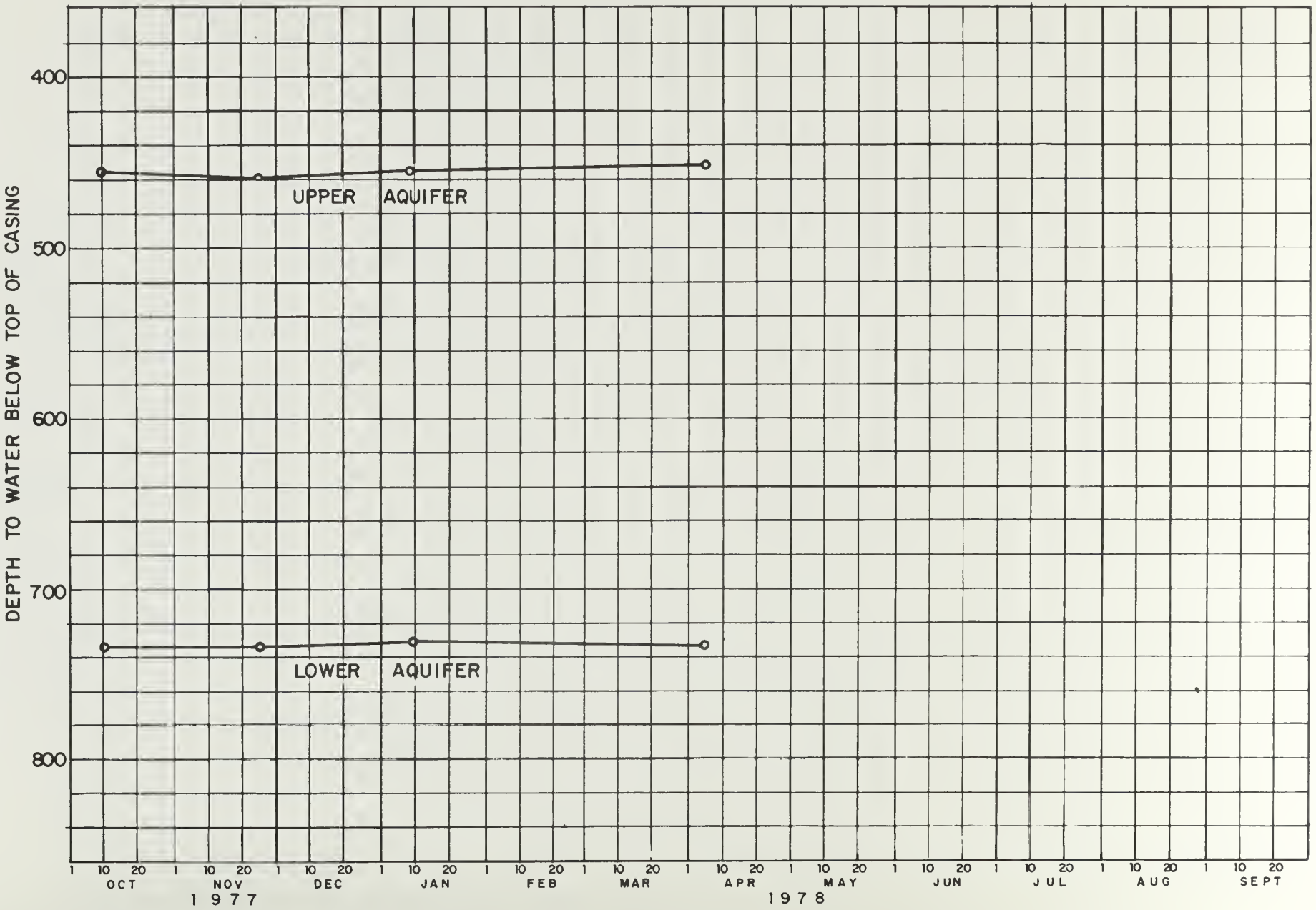
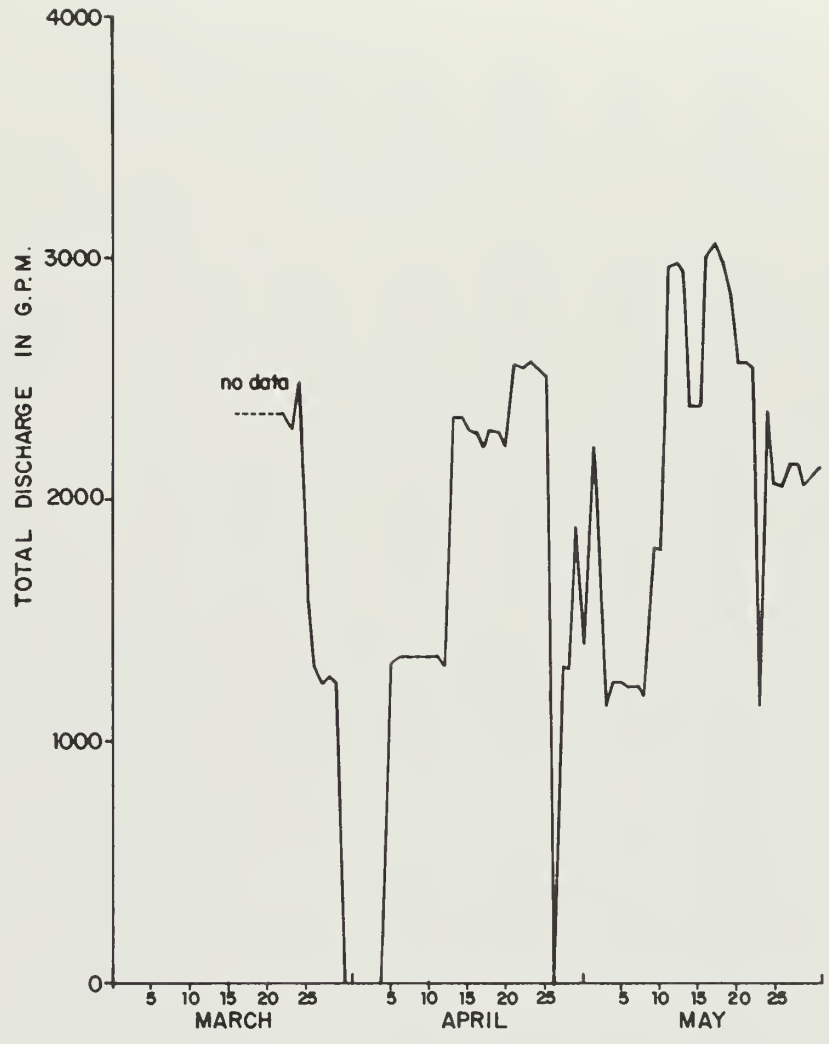

DEPTH TO WATER BELOW TOP OF CASING
400
500
600
700
800
UPPER AQUIFER
LOWER AQUIFER
1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20 1 10 20
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEPT
1977
1978

Figure 5-12. Depth to Water, Water Year 1978, Deep Aquifer Hole GS 11, Upper and Lower Aquifer.

Table 5-13. Water Levels for Deep Oil Shale Aquifer Wells.

	Upper Aquifer				Lower Aquifer		
Hole	Jan. 9	Jan. 18	Feb. 15	Apr. 15	Jan. 9	Feb. 15	Apr. 15
GS-11	457.03	456.34	455.84	455.06	728.43	734.37	----
GS-15	271.59	271.05	270.80	271.48	375.37	376.05	377.04
GS-M1	631.05	634.30	637.18	640.04	819.71	838.10	839.23
GS-M4			496.64	499.87	----	574.25	573.84
GS-M2				217.70	----	----	355.33



DISCHARGE OF DEWATERING
PUMPS D1, D2, D3 & D4
16 March 78 thru 31 May 78

Figure 5-14. Total Daily Discharge of Dewatering Wells D1, D2, D3, and D4, March through May, 1978.

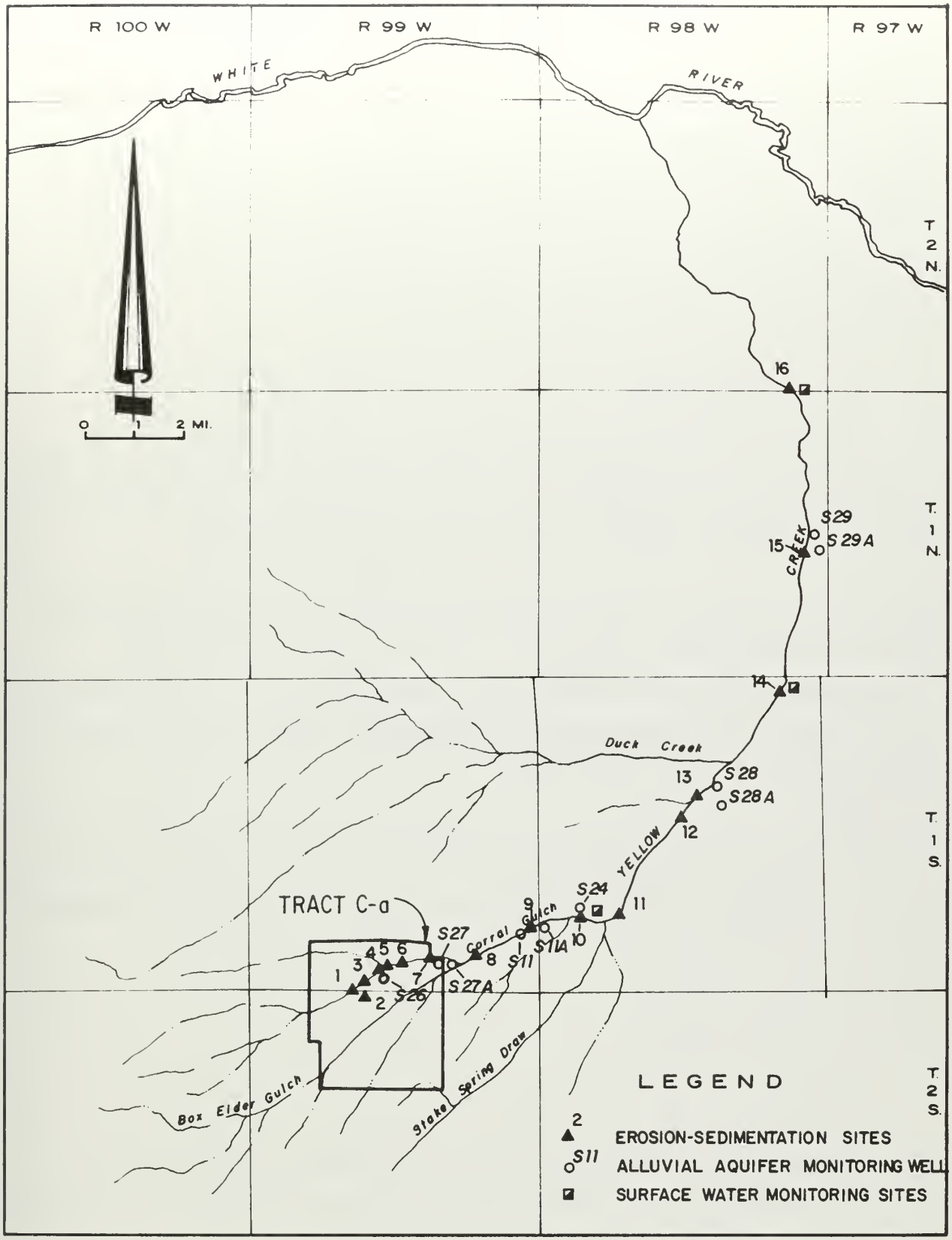


Figure 5-15. Location of MDP Pump Test Monitoring Sites.

1. Methods

Flow, conductivity, and pH are measured at each of the three additional surface water gaging stations. The flow measurements are made by means of a V-notch weir. Conductivity and pH were made once daily for three days prior to flow, and twice daily for the first week after flow commenced. After the first week, the surface water, pH and conductivity were measured twice a month.

3. Results and Discussion

Flow, conductivity and pH measurements taken from 25 February to 31 May are shown on Figures 5-16 through 5-21. Data from 10 March through 30 March are shown at an expanded scale in order to show daily fluctuations.

The bulk of the data for this reporting period was collected at the gaging station at Corral Gulch at 84 Ranch. Initial water quality data were collected on 18 March from Yellow Creek at Square S Ranch and on 5 April from Yellow Creek 2.5 miles downstream of Pinto Gulch. V-notch weirs are currently being installed at these two sites.

An examination of the graphs of flow and water quality along with the graph of daily dewatering pump discharge shows little correspondence in fluctuation. Statistical analysis will be performed in the year-end report to determine if any relationship exists.

B. Alluvial Groundwater

1. Objectives

The objective of monitoring the alluvial holes during the pumping test is to determine the impact of dewatering well discharge on water level and water quality in the alluvial aquifer.

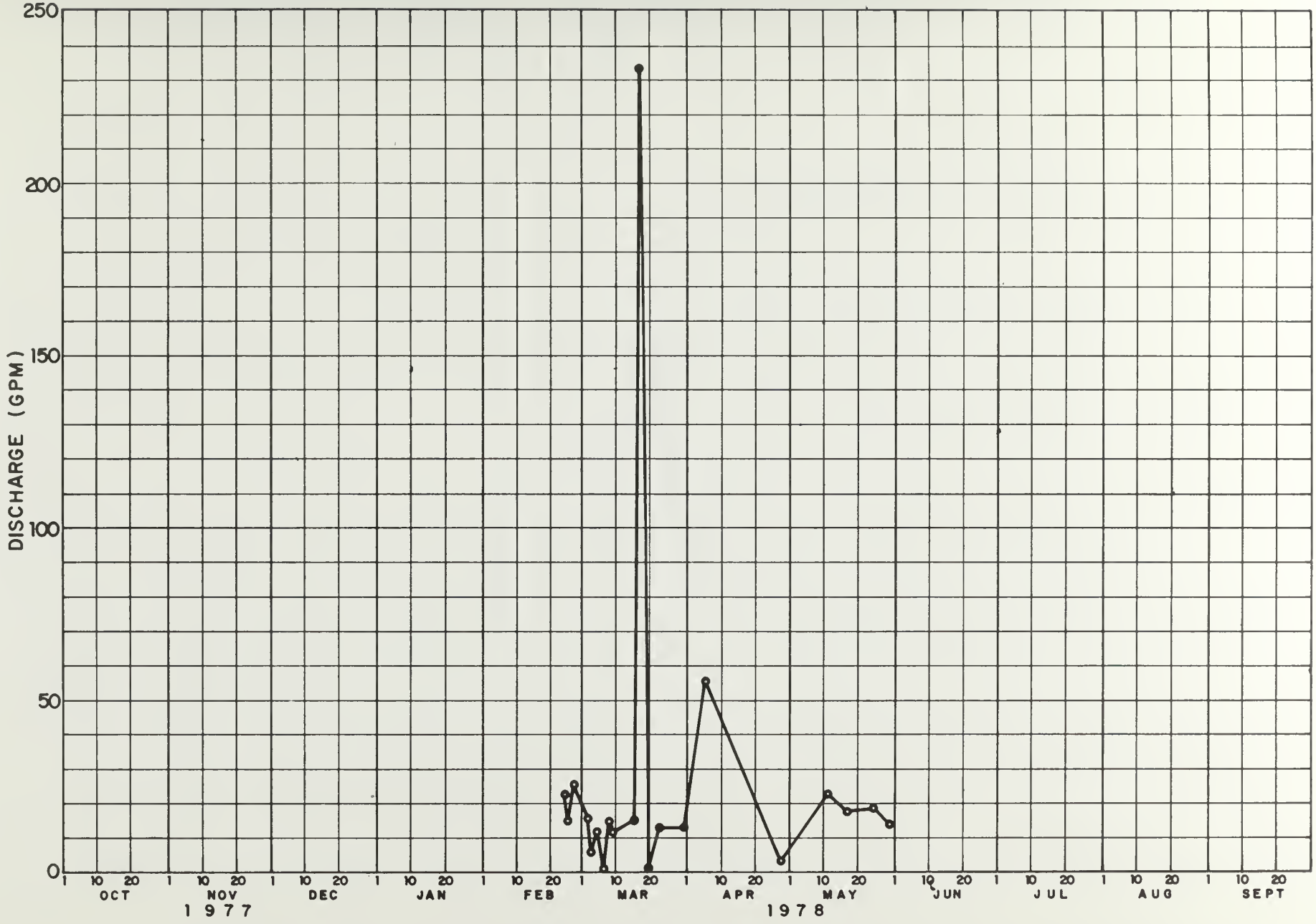


Figure 5-16. Flow at Corral Gulch at 84 Ranch, 25 February to 31 May.

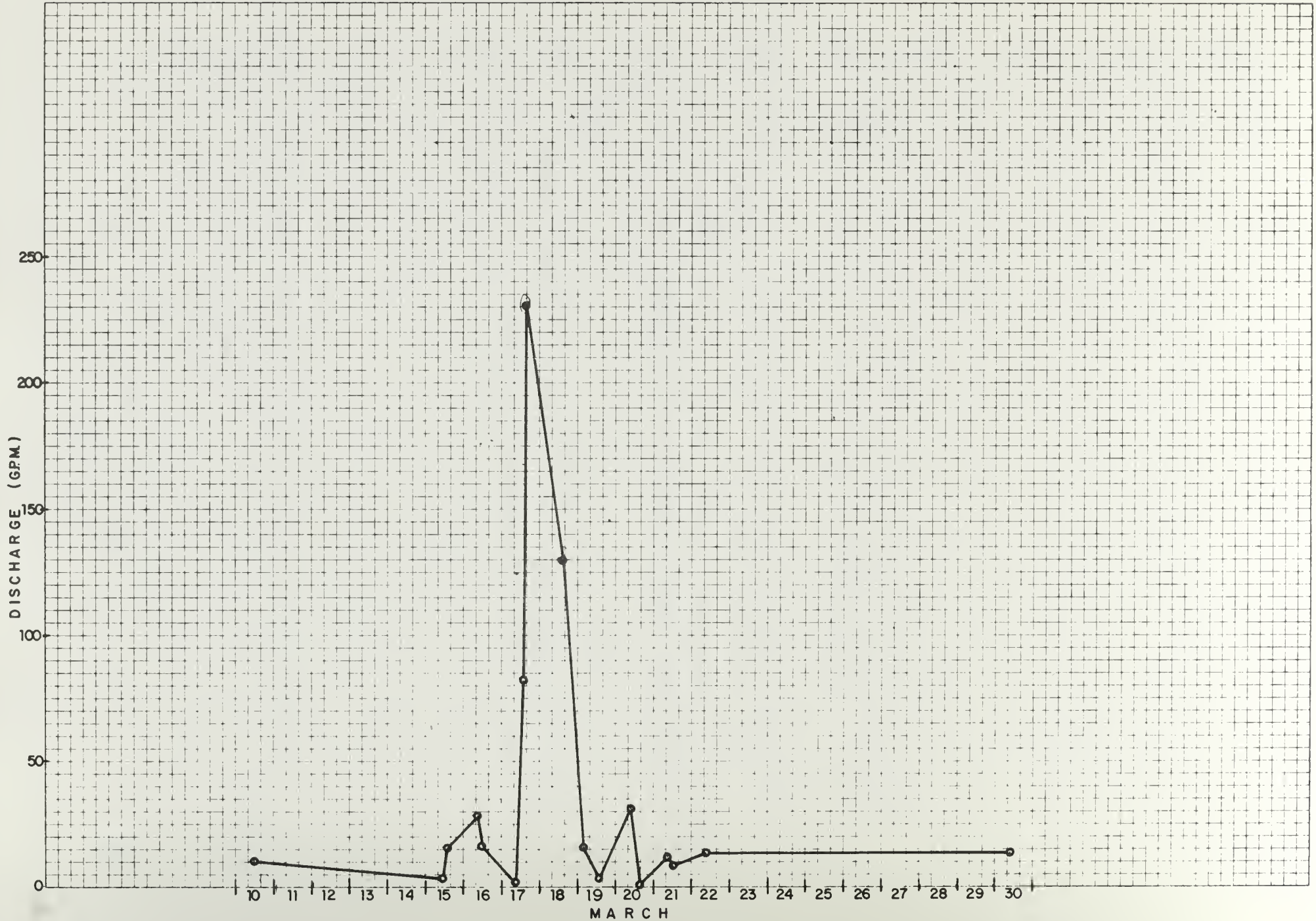


Figure 5-17. Flow at Corral Gulch at 84 Ranch, 10 March to 30 March.

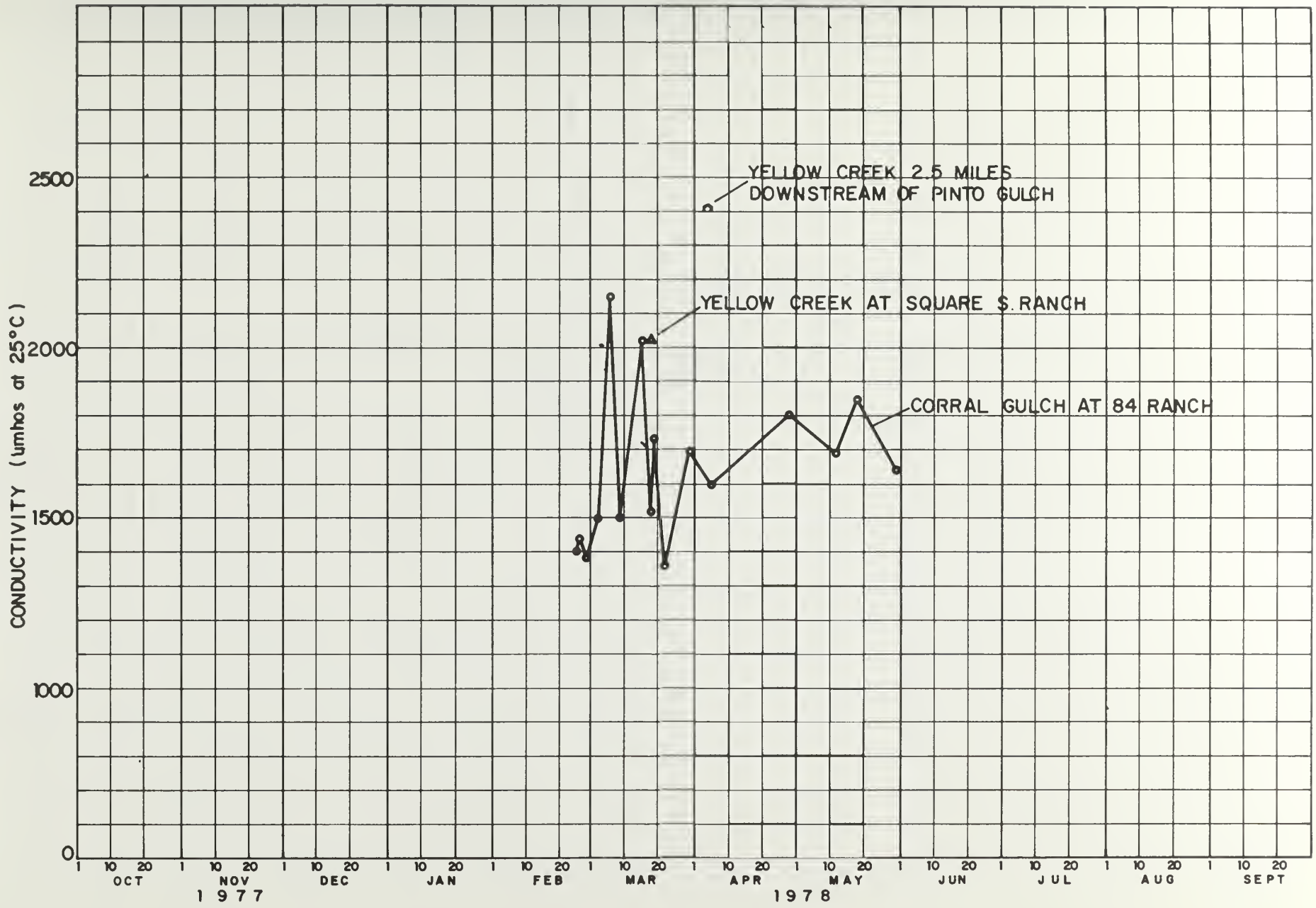


Figure 5-18. Conductivity at Surface Water Stations in Vicinity of Tract C-a, 25 February to 31 May.

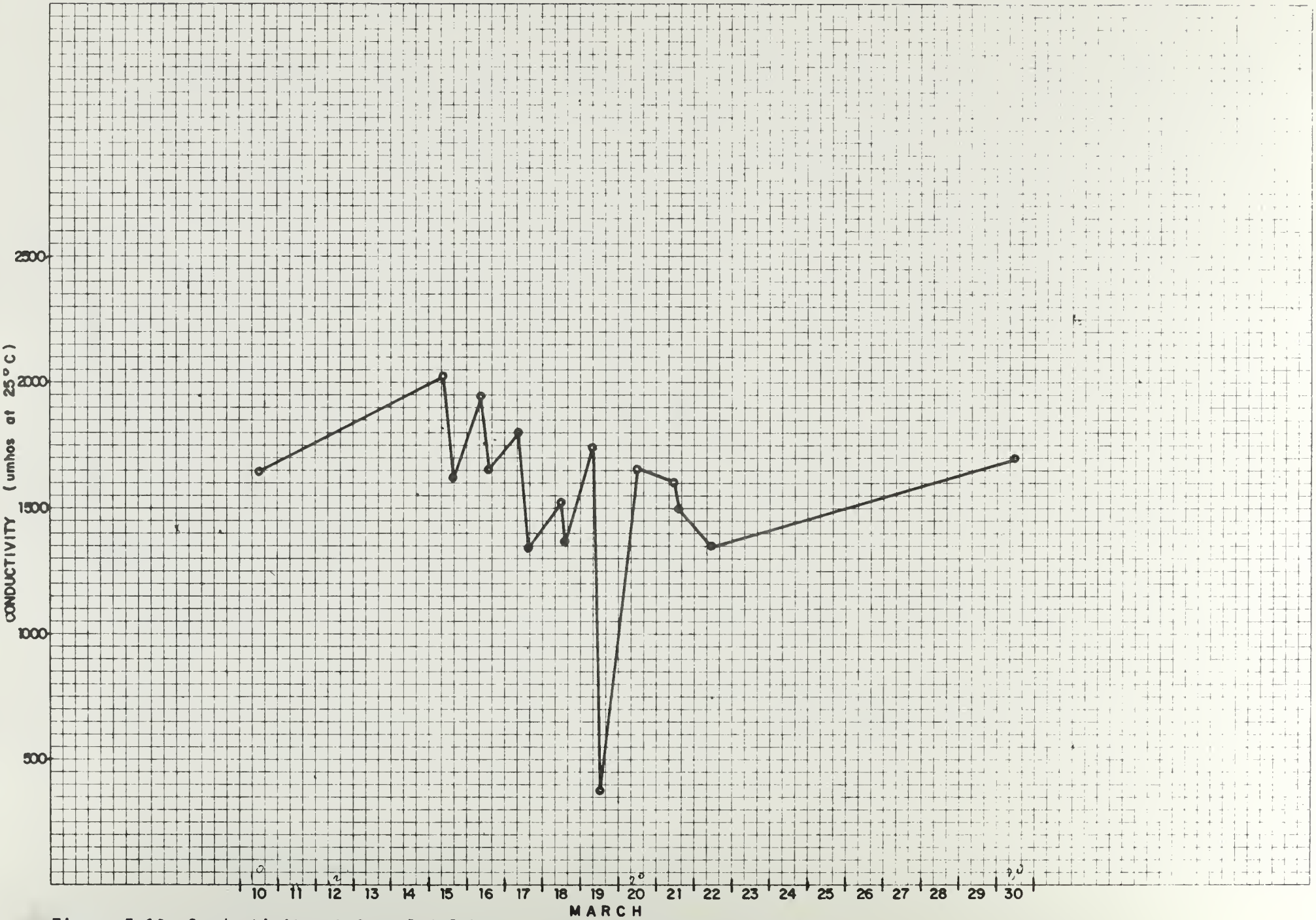


Figure 5-19. Conductivity at Corral Gulch at 84 Ranch, 10 March to 30 March.

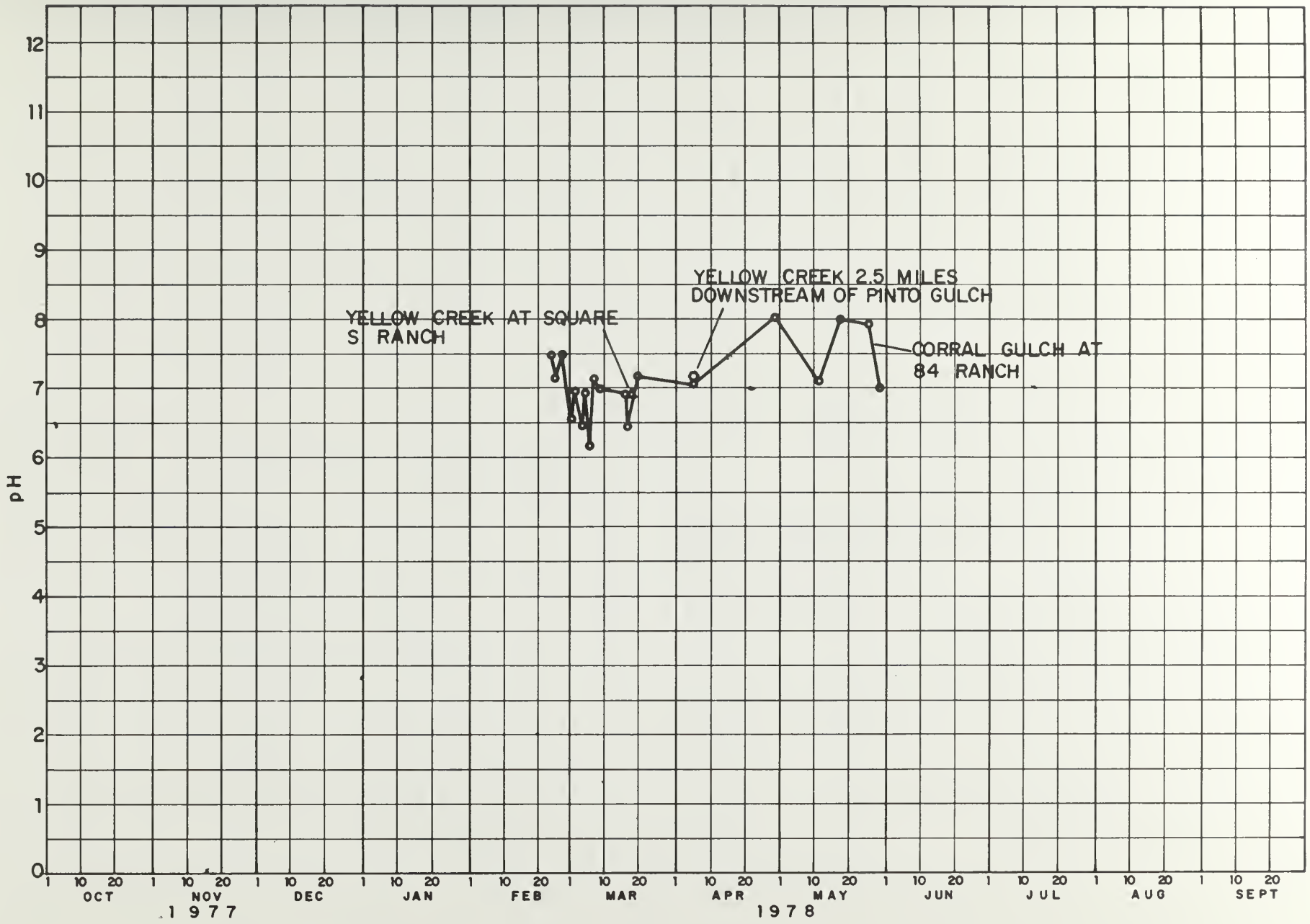


Figure 5-20. pH at Surface Water Gaging Stations in the Vicinity of Tract C-a, 25 February to 31 May.

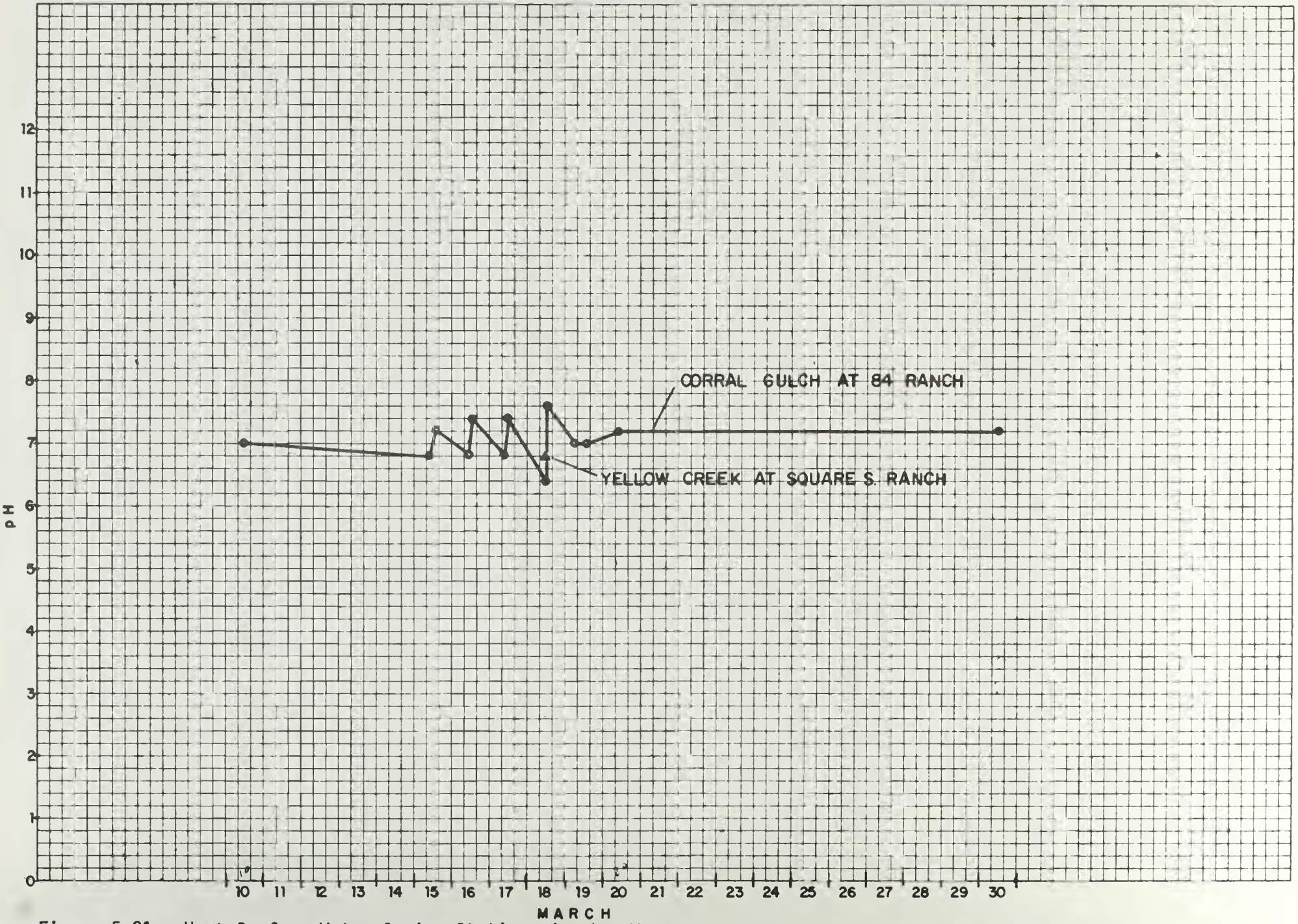


Figure 5-21. pH at Surface Water Gaging Stations in the Vicinity of Tract C-a, 10 March to 30 March.

2. Methods

The static or dynamic water level, conductivity, temperature, and pH was measured once daily for three days prior to flow at any given site. In addition, the major and minor chemical constituents were analyzed at each of the new alluvial monitor holes found to have water or as water encountered the new holes. These parameters were measured once daily for the first two to three days after flow commenced in the surface drainage near the alluvial hole and then once weekly until conditions stablized. The current monitoring frequency is bimonthly.

3. Results and Discussion

Water level, conductivity, temperature, and pH measurements from February 25th through May 31 are plotted on Figures 5-22 through 5-39.

Eight new alluvial holes adjacent to Yellow Creek, GS S-28 (deep and shallow) GS S-28a (deep and shallow), GS S-29 (deep and shallow), and GS S-29a (deep and shallow), were constructed the third week of March.

The geologic logs, casing programs, and initial water quality analyses for these holes are included in Appendix 5-1 and 5-3.

Water quality data were not collected from GS S-11a until May 25. Prior to May 11th, there was not enough water in the hole to sample. After May 11, seepage of surface water into the hole around the casing made a true alluvial sample impossible to collect. This situation was corrected and the hole was sampled for the first time May 25.

Water level in the alluvial aquifer has risen steadily since the dewatering pumps began. Water quality parameters have varied considerably during the pump test monitoring. Conditions at all monitoring points seem to have been fairly stable throughout April and May.

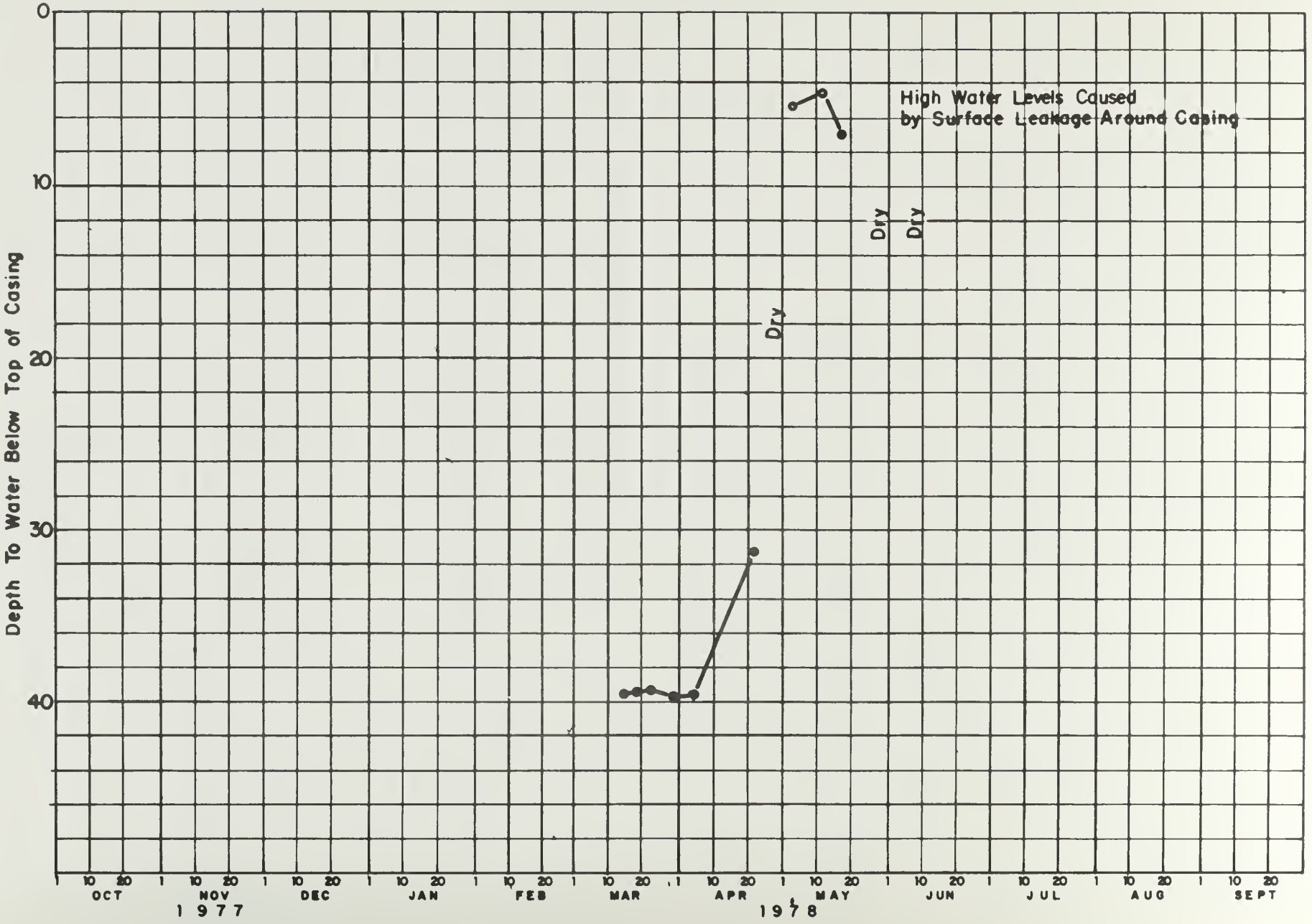


Figure 5-22. Depth to Water, 15 March to 31 May, Alluvial Hole GS S-11A (Shallow).

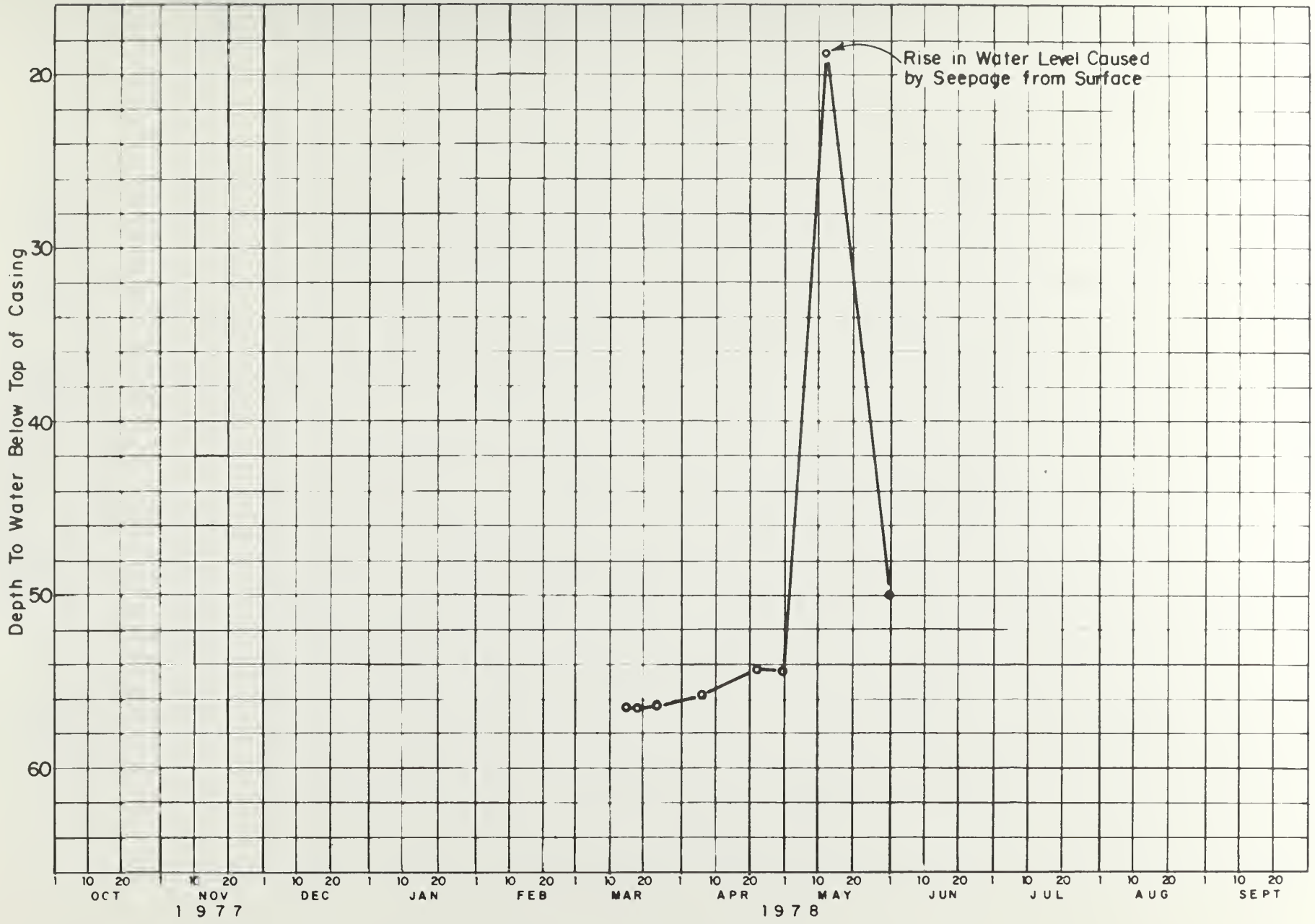


Figure 5-23. Depth to Water, 15 March to 31 May, Alluvial Hole GS S-11A (Deep).

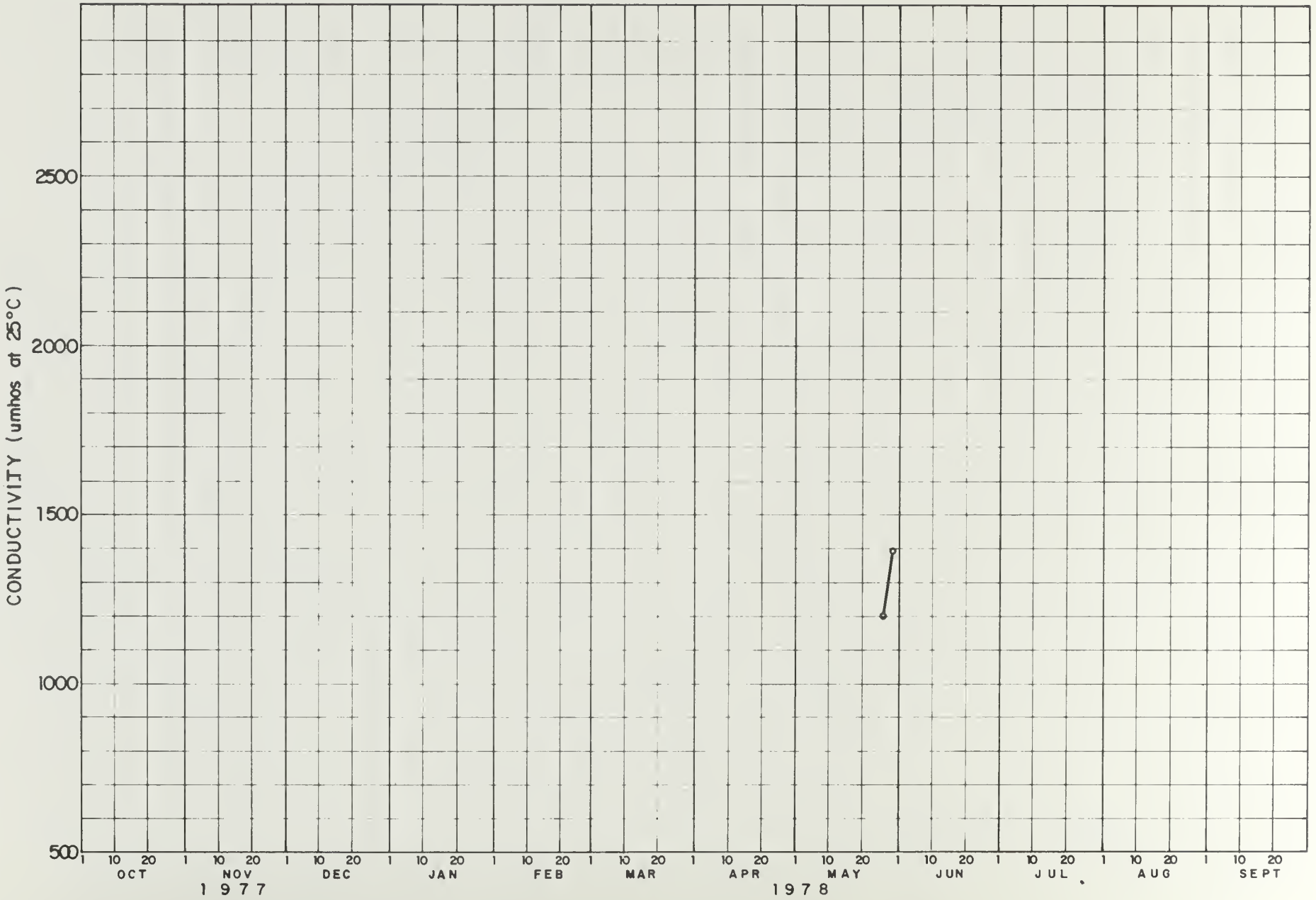


Figure 5-24. Conductivity at Alluvial Hole GS S-11A (Deep), 25 May to 31 May.

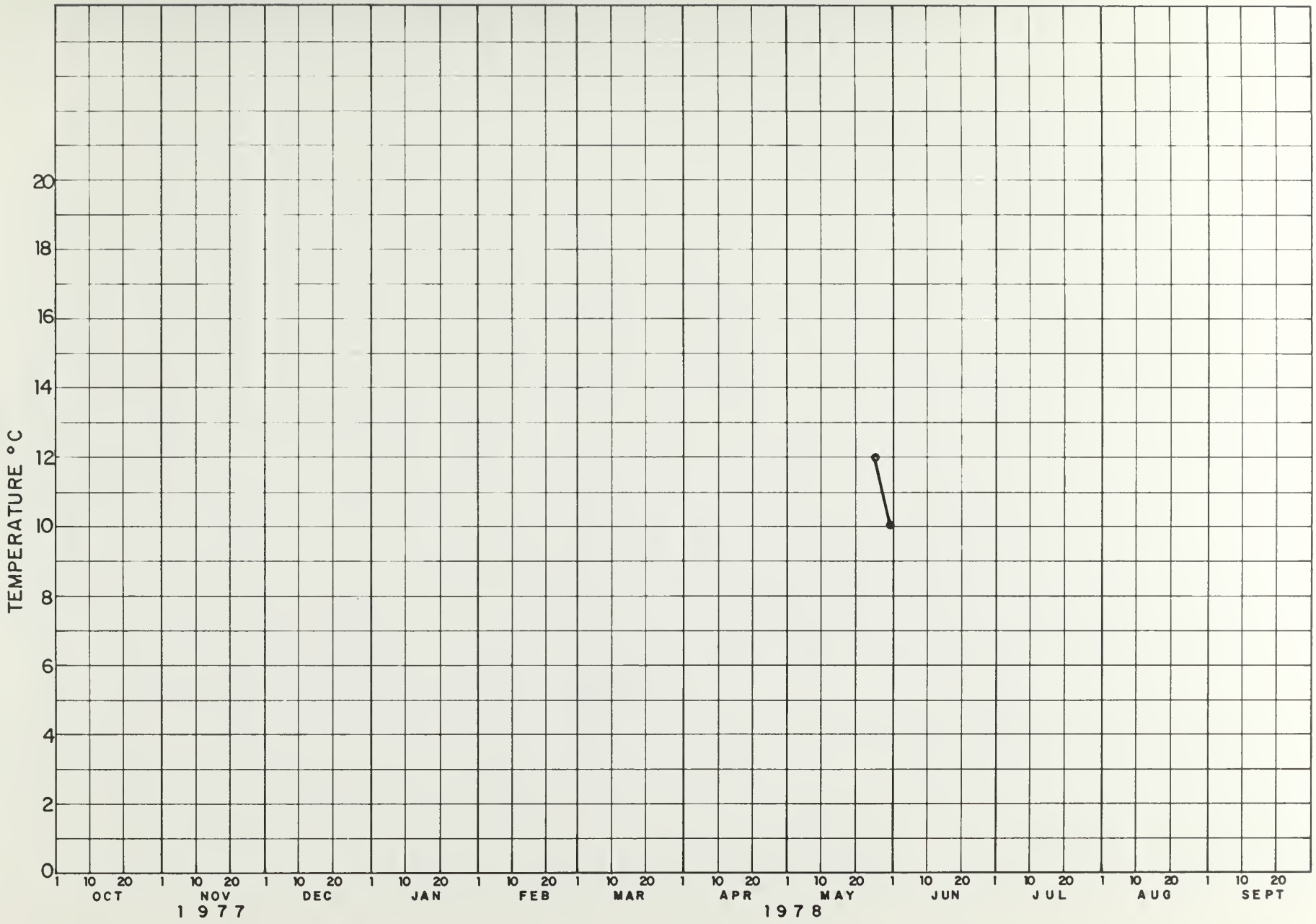


Figure 5-25. Temperature at Alluvial Hole GS S-11A (Deep), 25 May to 31 May.

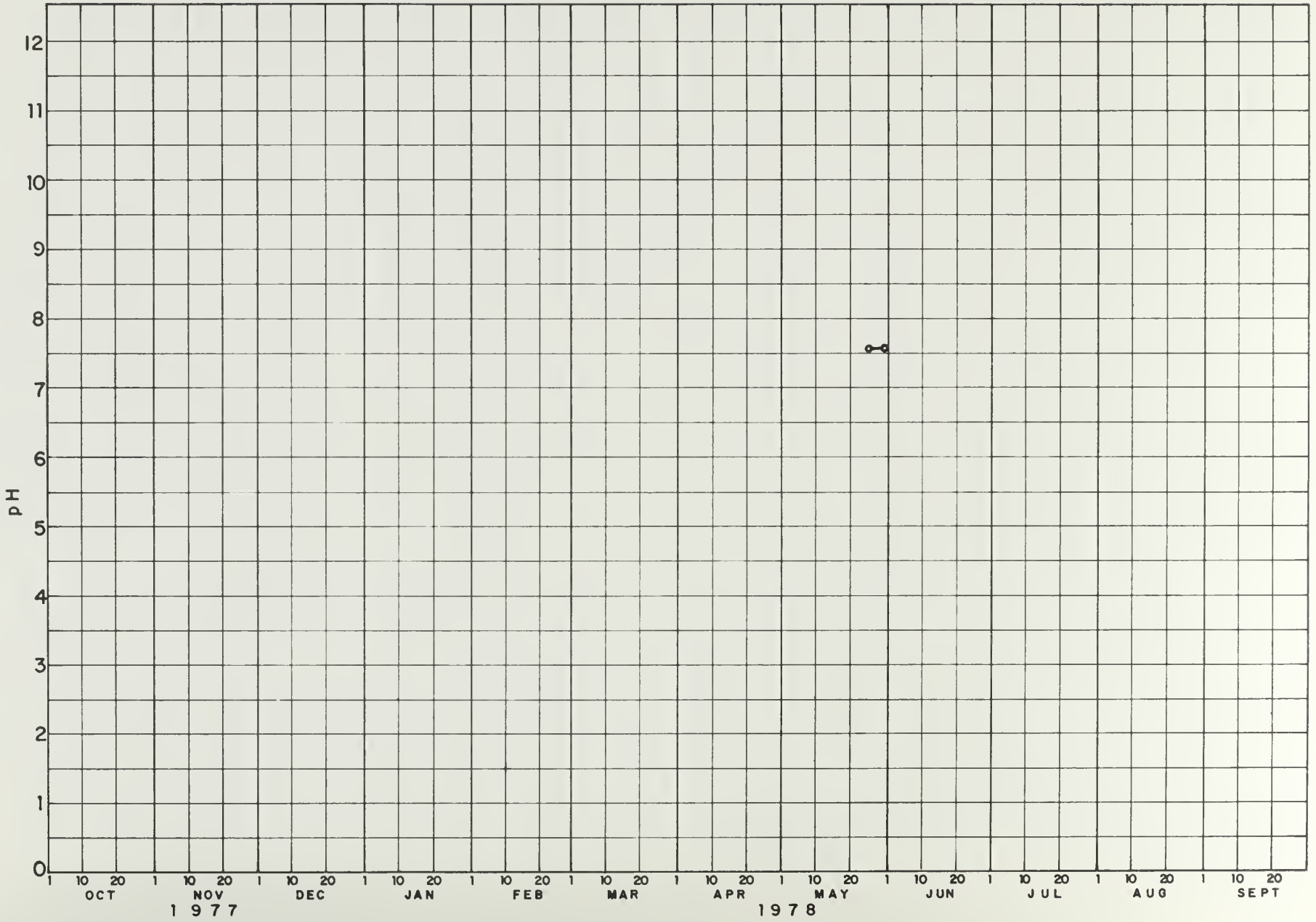


Figure 5-26. pH at Alluvial Hole GS S-11A (Deep), 25 May to 31 May.

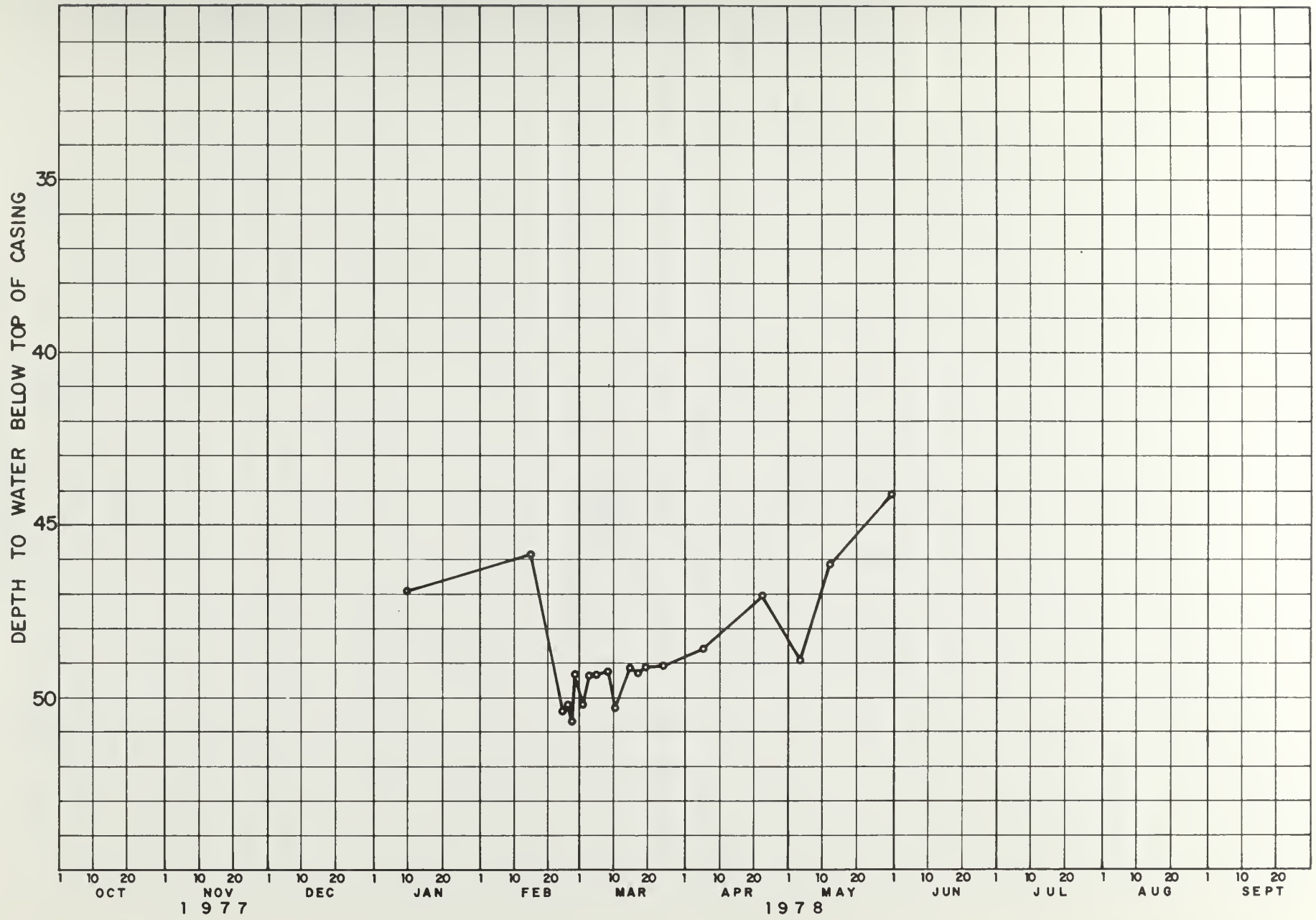


Figure 5-27. Depth to Water, 10 January to 31 May, Alluvial Hole GS S-11 (Deep).

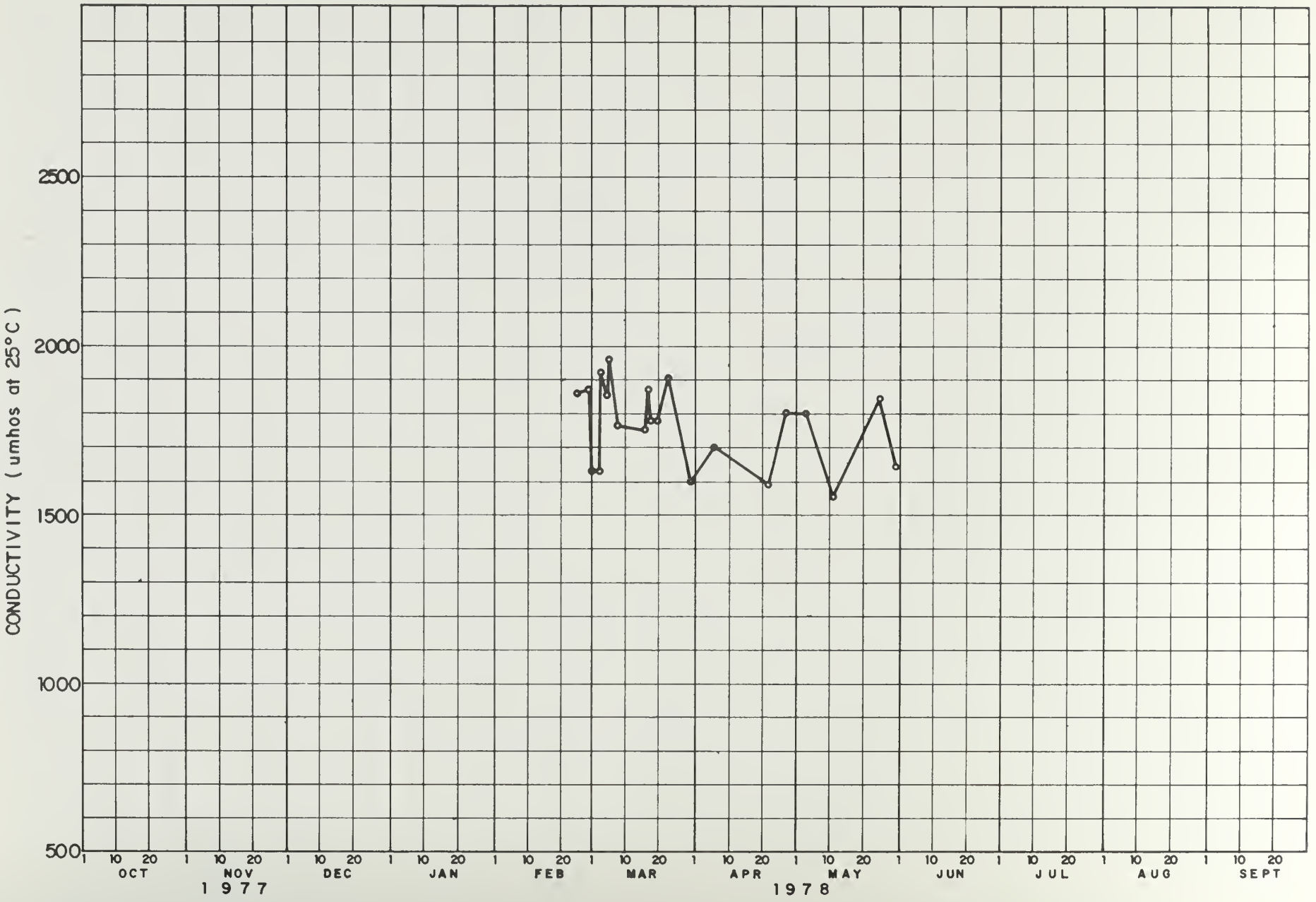


Figure 5-28. Conductivity at Alluvial Hole GS S-11 (Deep), 25 February to 31 May.

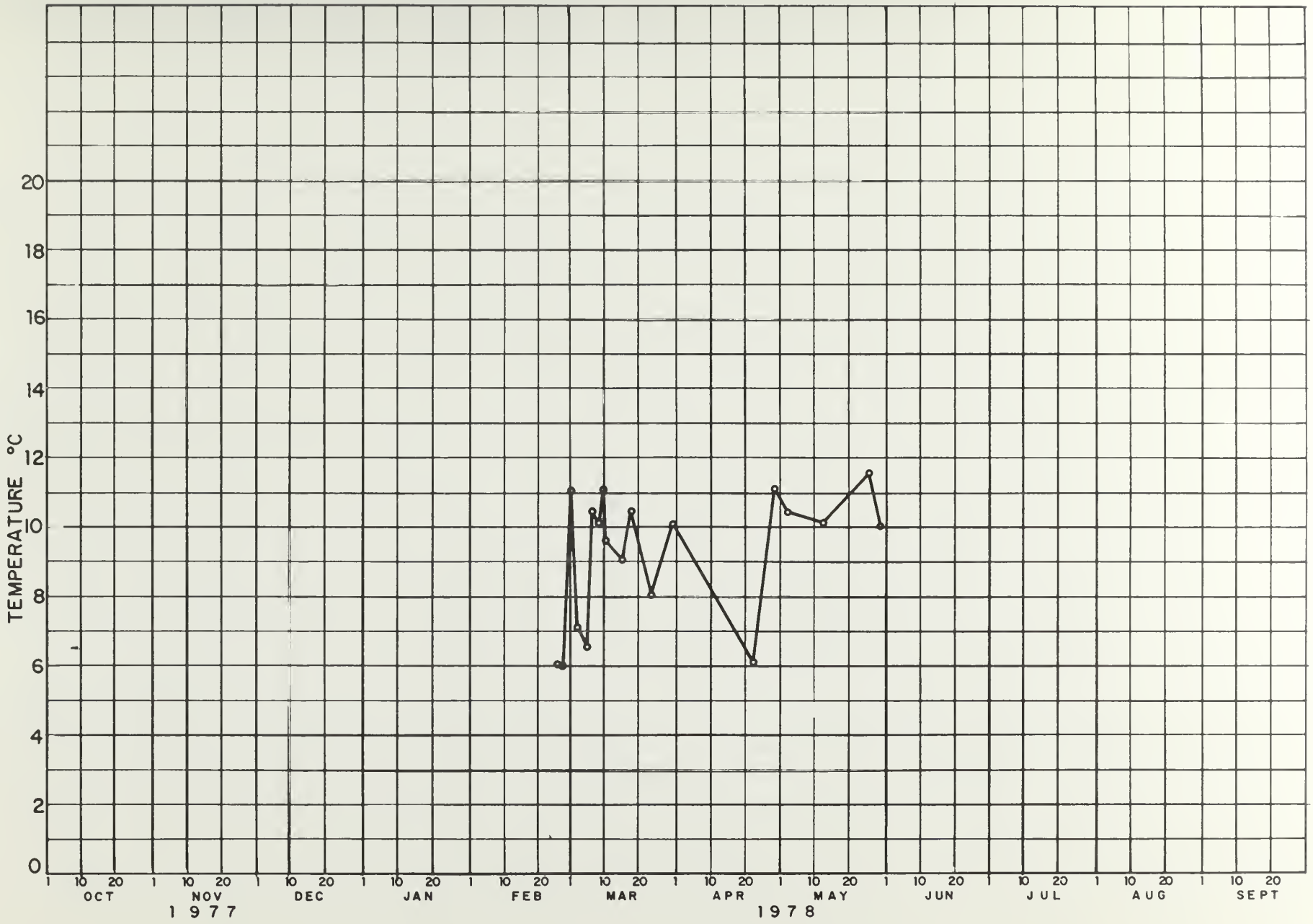


Figure 5-29. Temperature at Alluvial Hole GS S-11 (Deep), 25 February to 31 May.

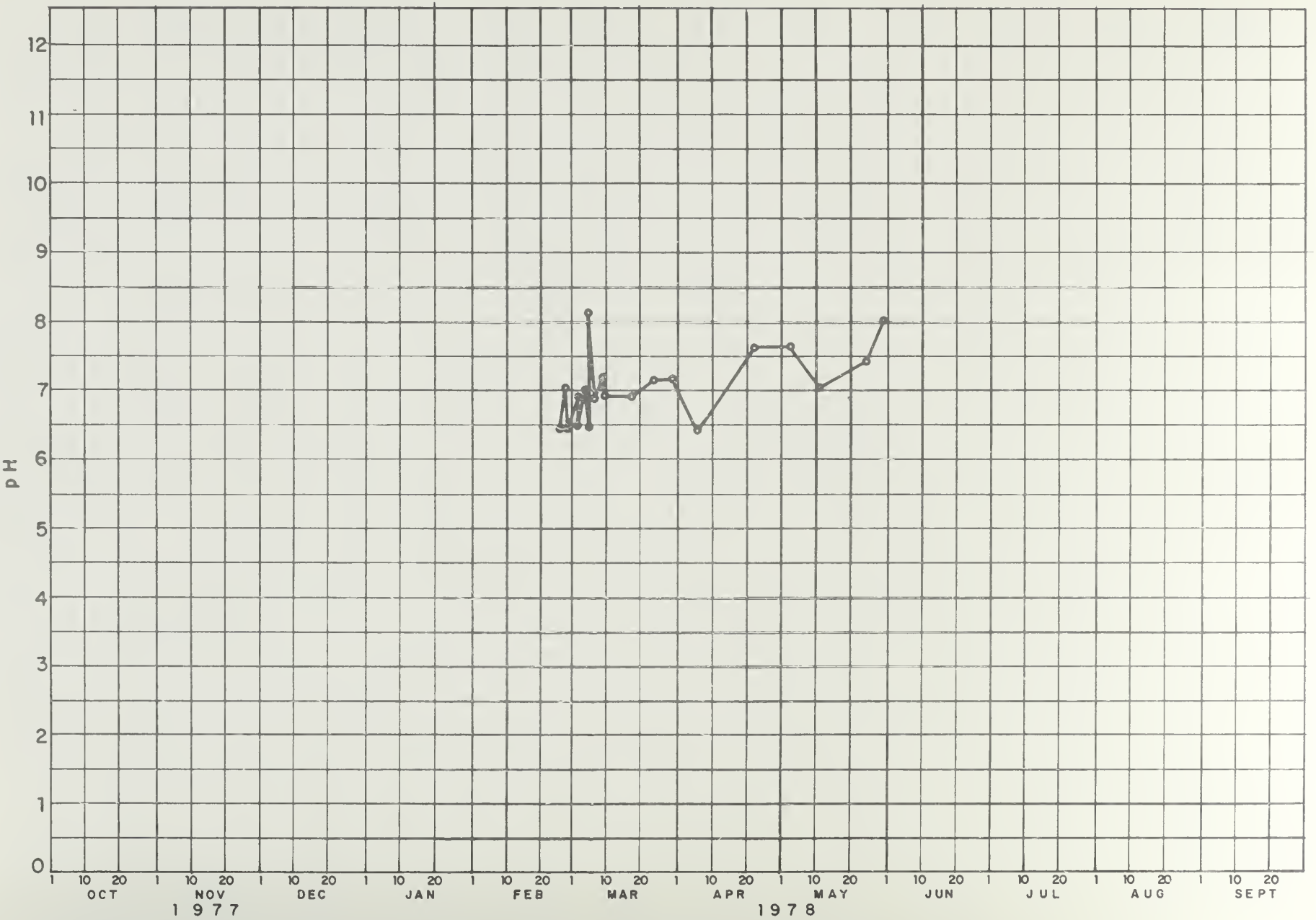


Figure 5-30. pH at Alluvial Hole GS S-11 (Deep), 25 February to 31 May.

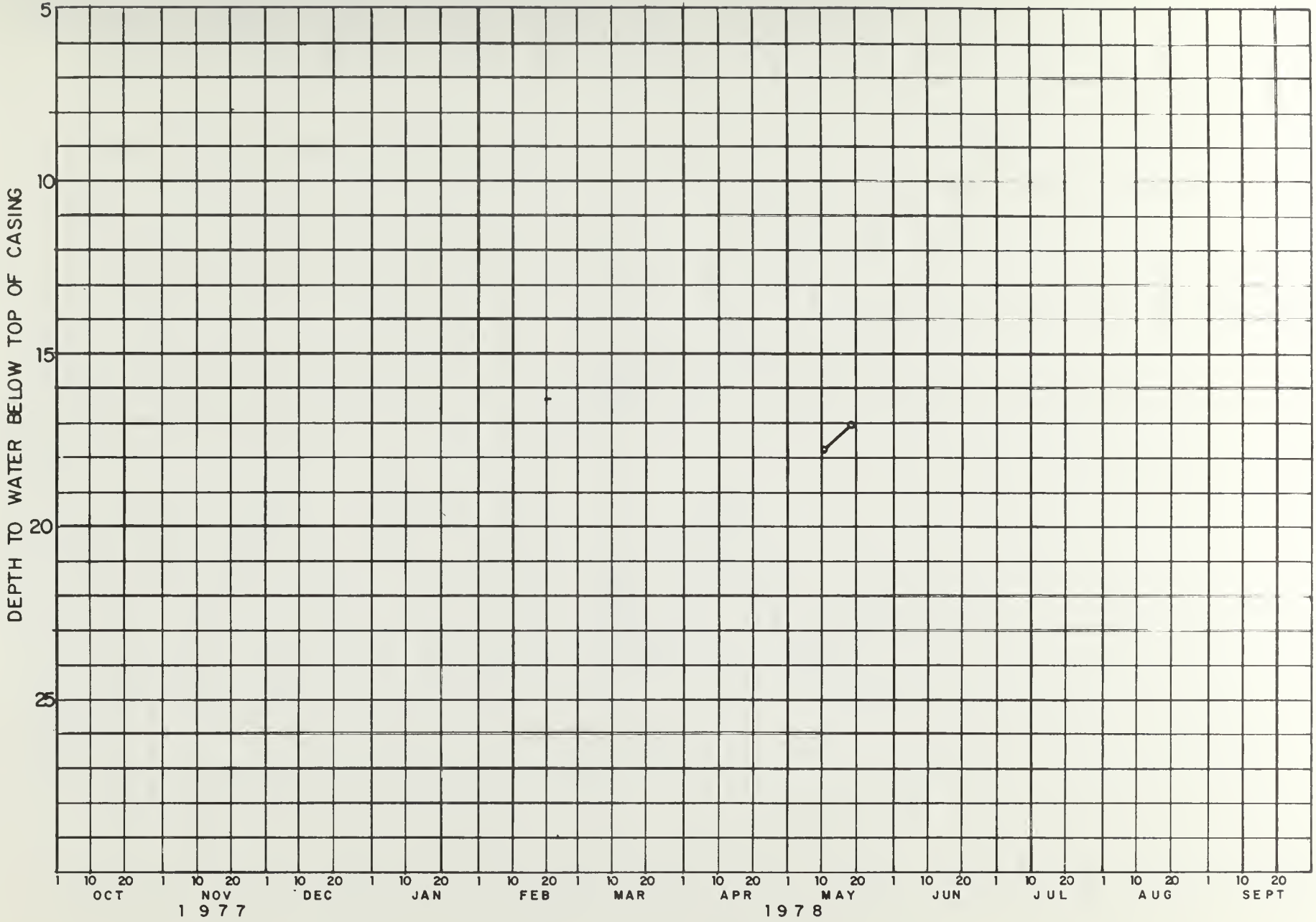


Figure 5-31. Depth to Water, 11 May to 31 May, Alluvial Hole GS.S-27A.

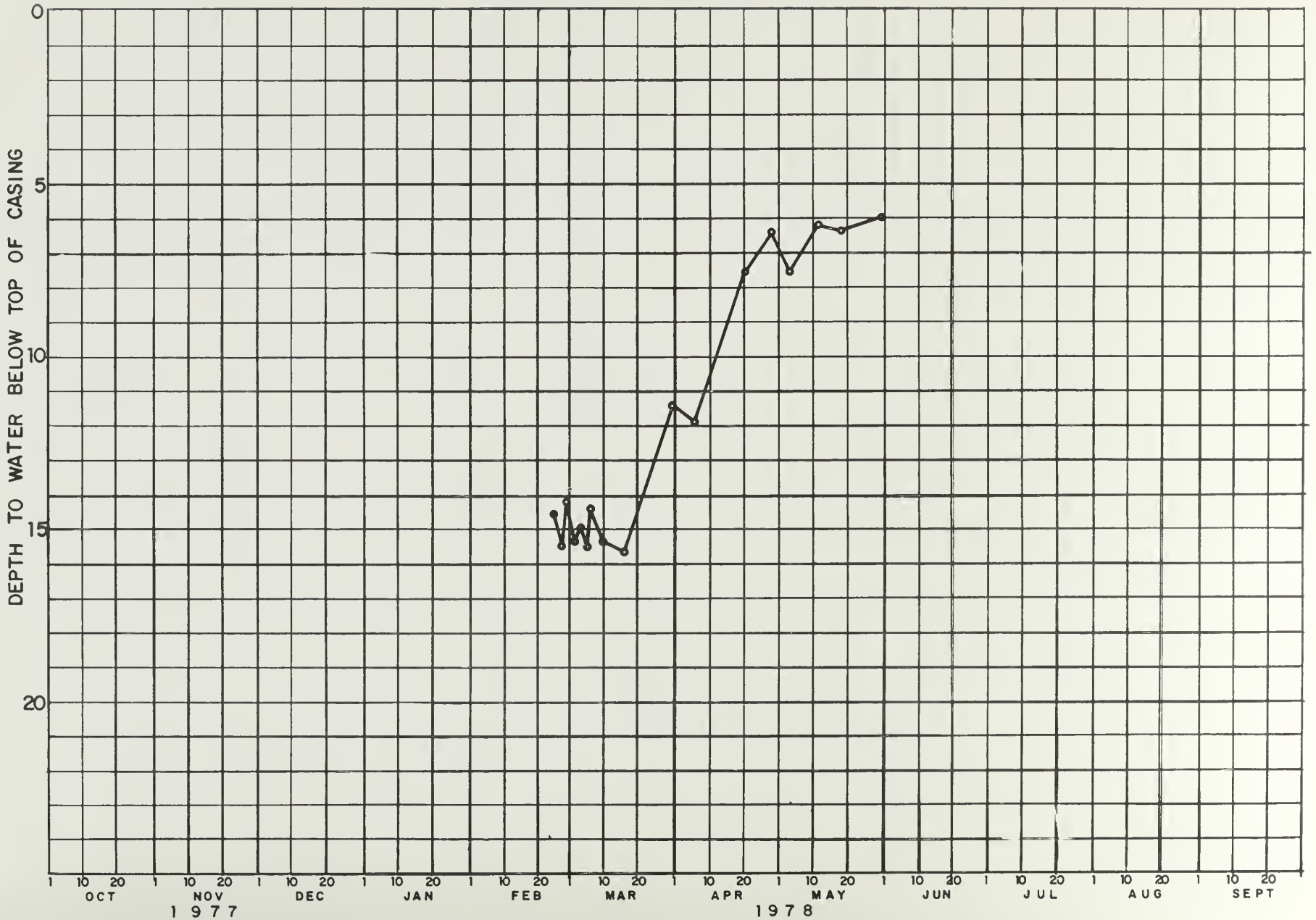


Figure 5-32. Depth to Water, Alluvial Hole GS S-27, 25 February to 12 June.

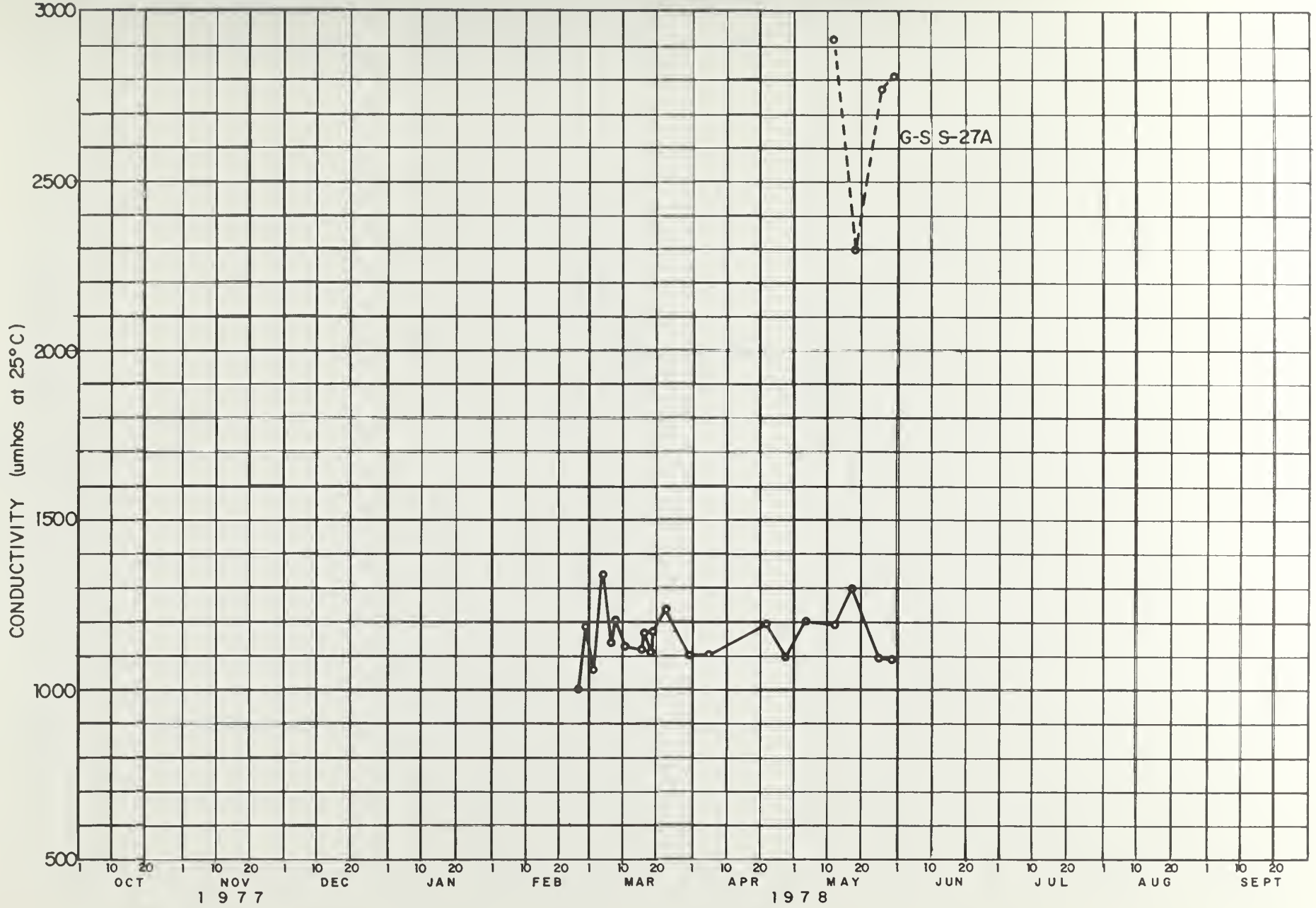


Figure 5-33. Conductivity at Alluvial Hole GS S-27, 25 February to 31 May.

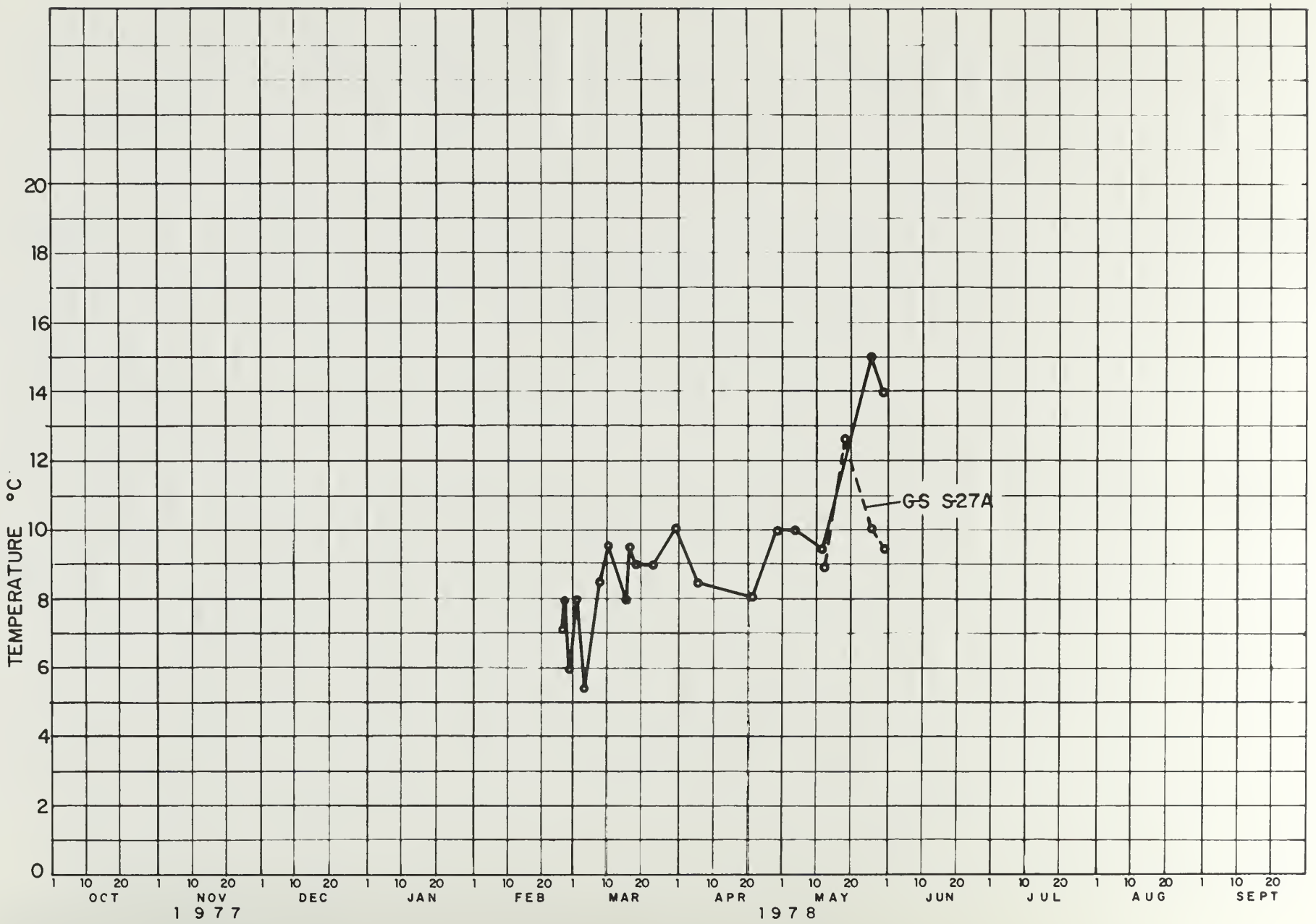


Figure 5-34. Temperature at Alluvial Hole GS S-27, 25 February to 31 May.

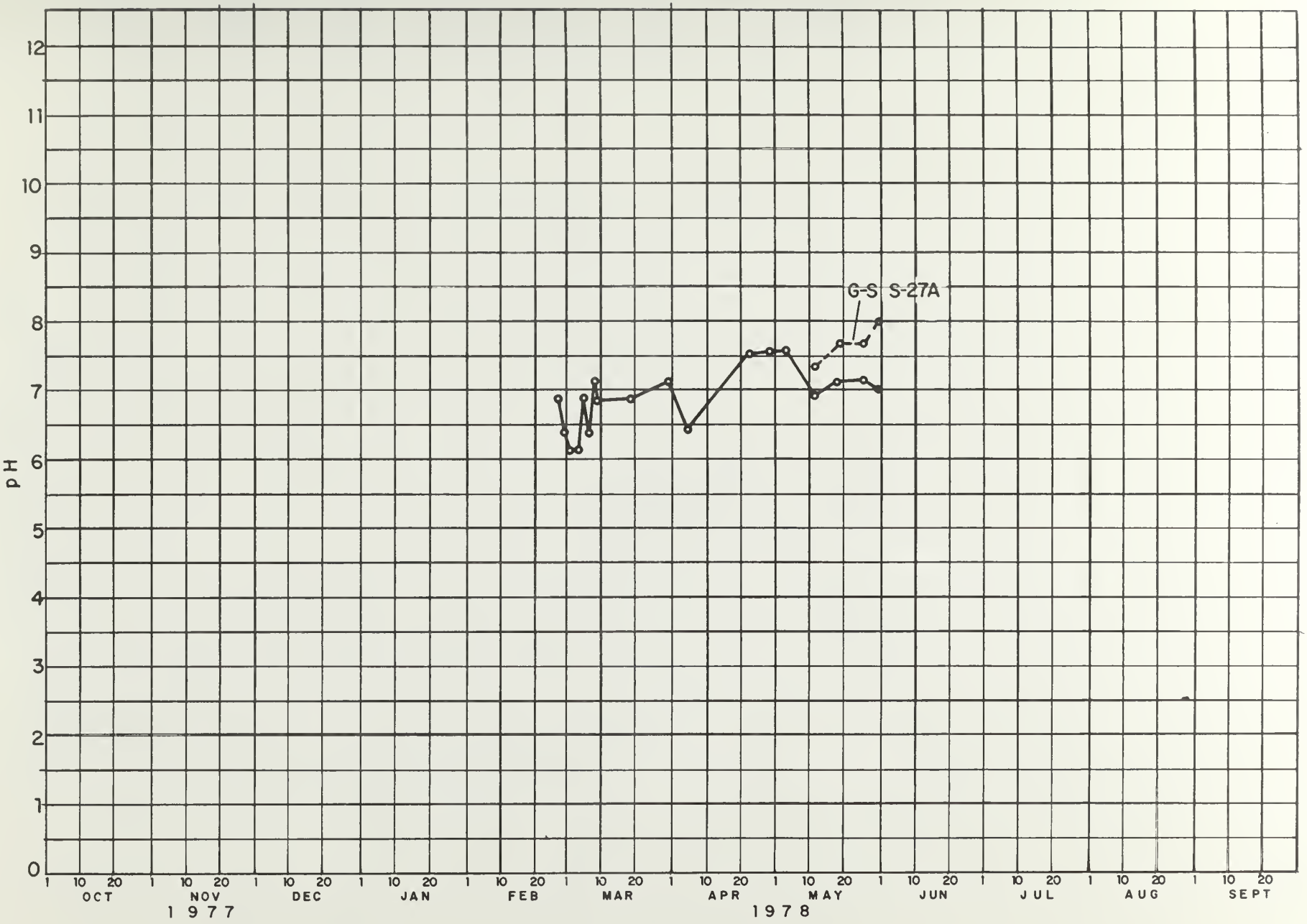


Figure 5-35. pH at Alluvial Hole GS S-27, 25 February to 31 May.

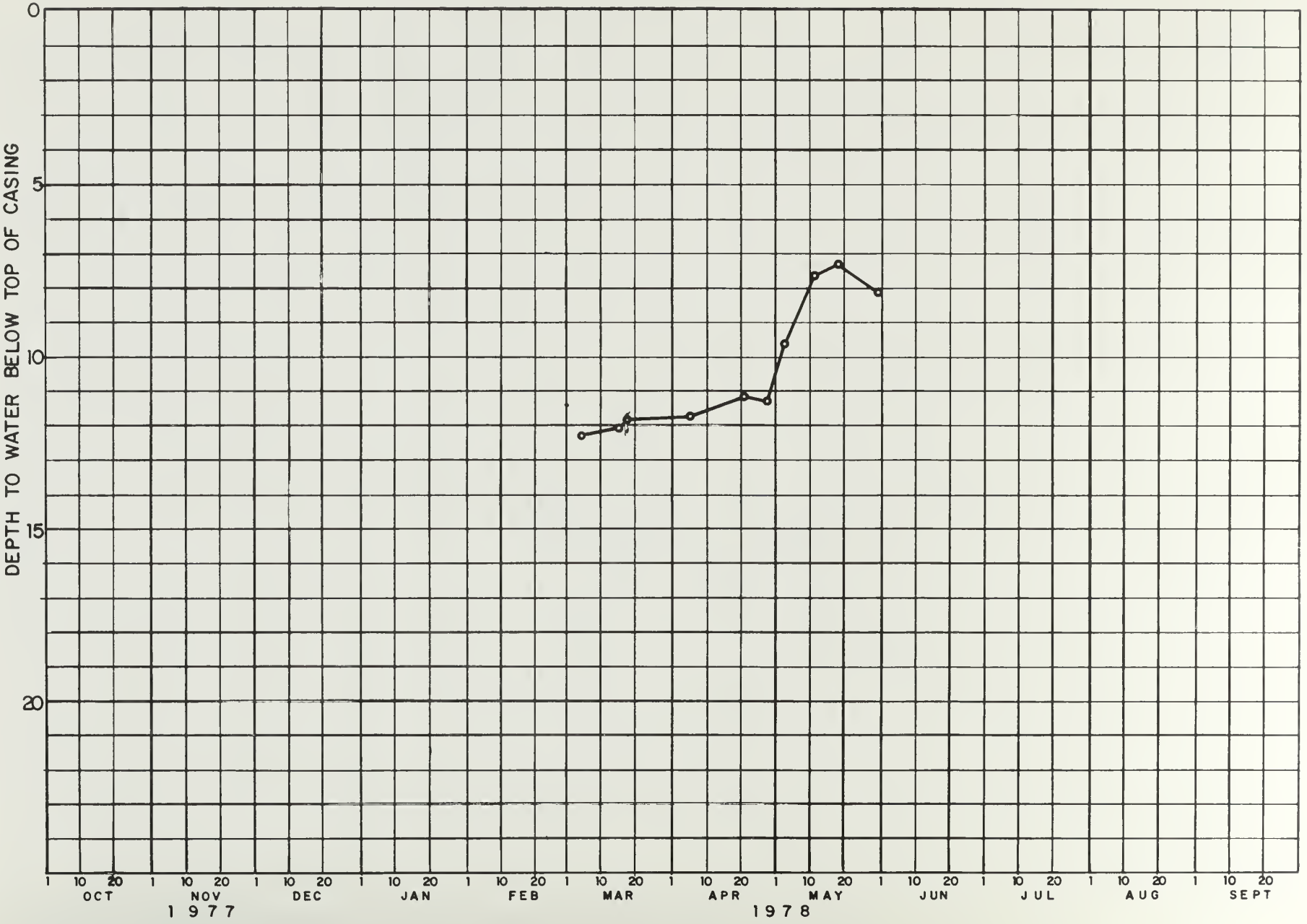


Figure 5-36. Depth to Water, Alluvial Hole GS S-24, 5 March to 31 May.

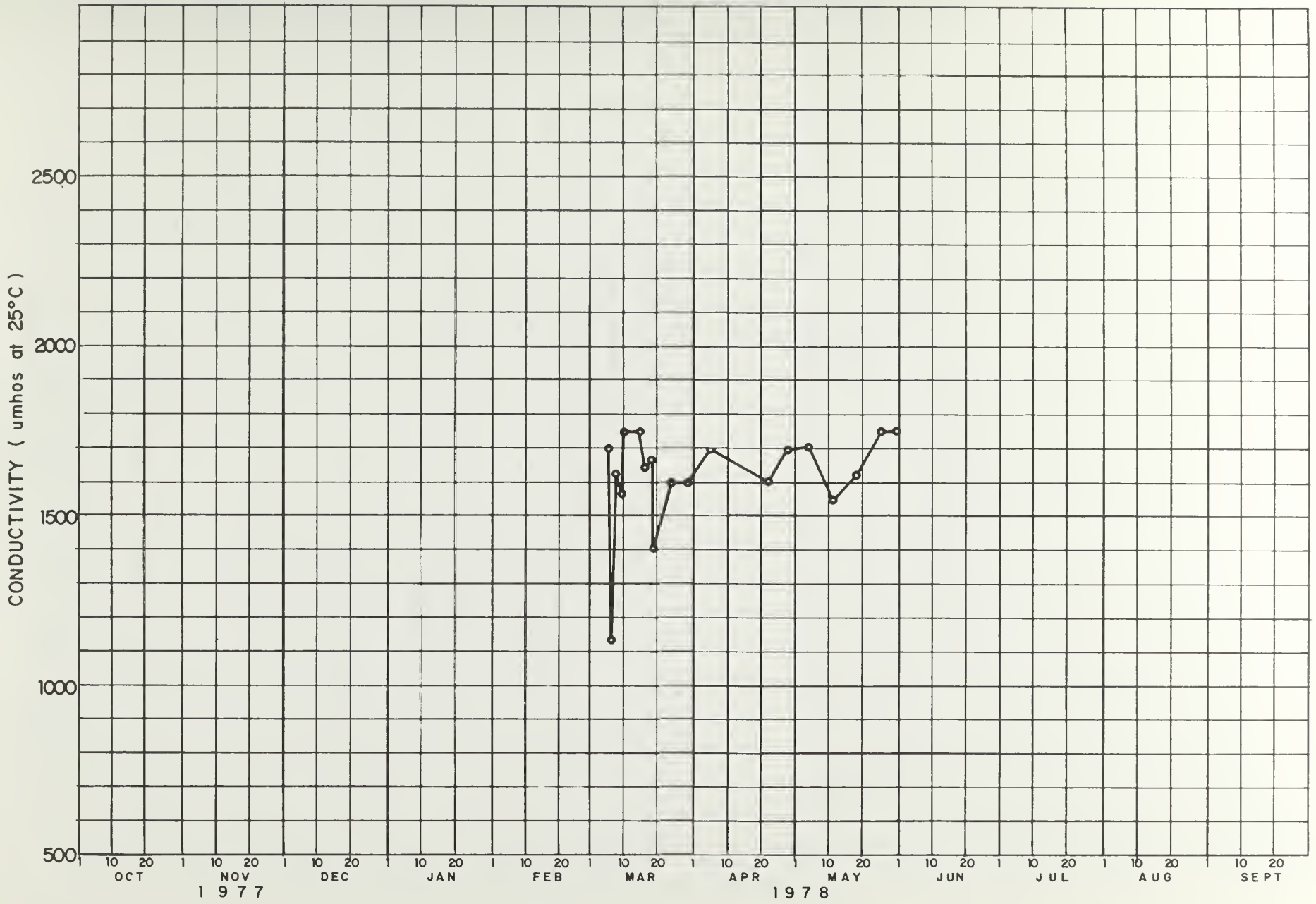


Figure 5-37. Conductivity at Alluvial Hole GS S-24, 5 March to 31 May.

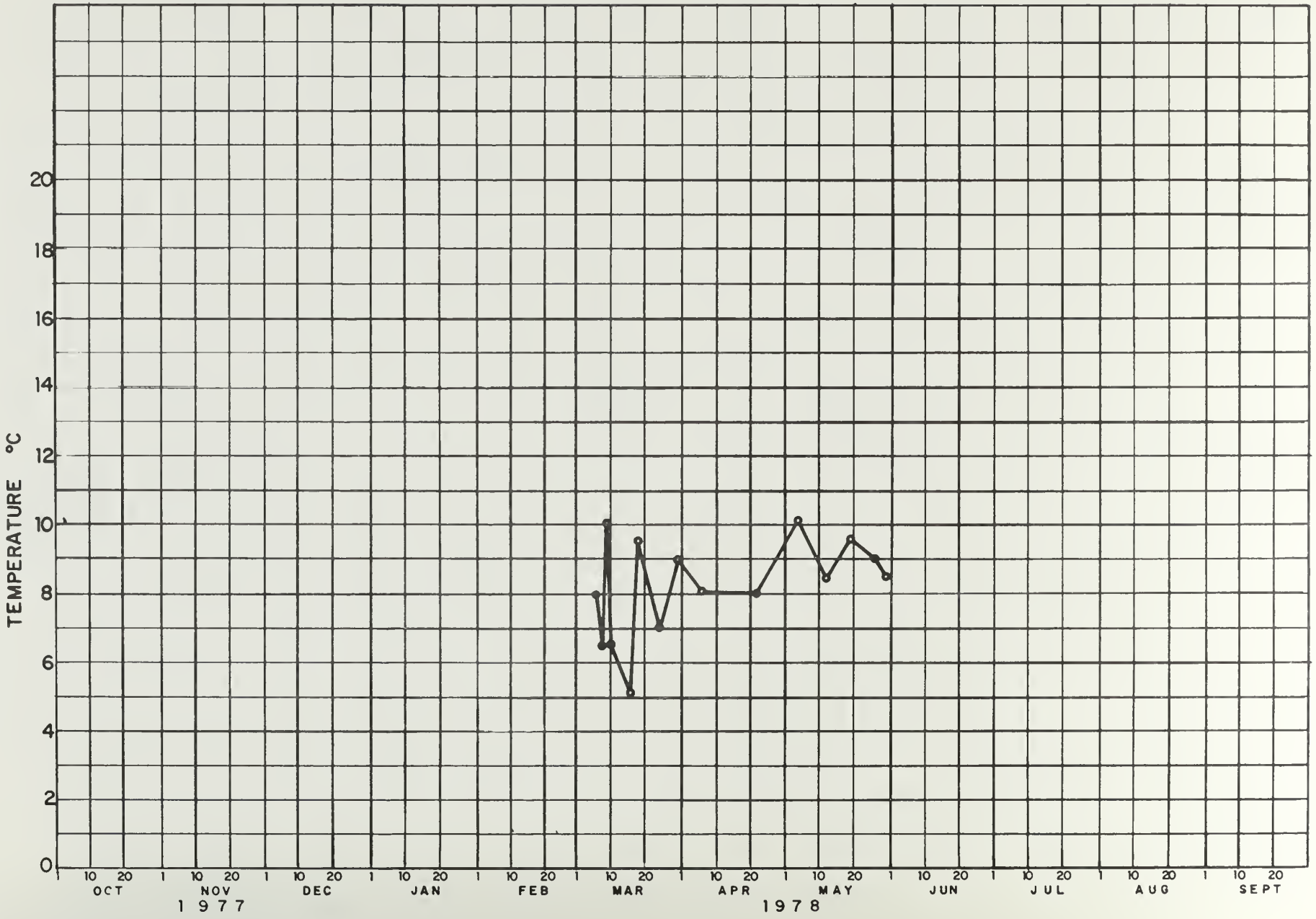


Figure 5-38. Temperature at Alluvial Hole GS S-24, 5 March to 31 May.

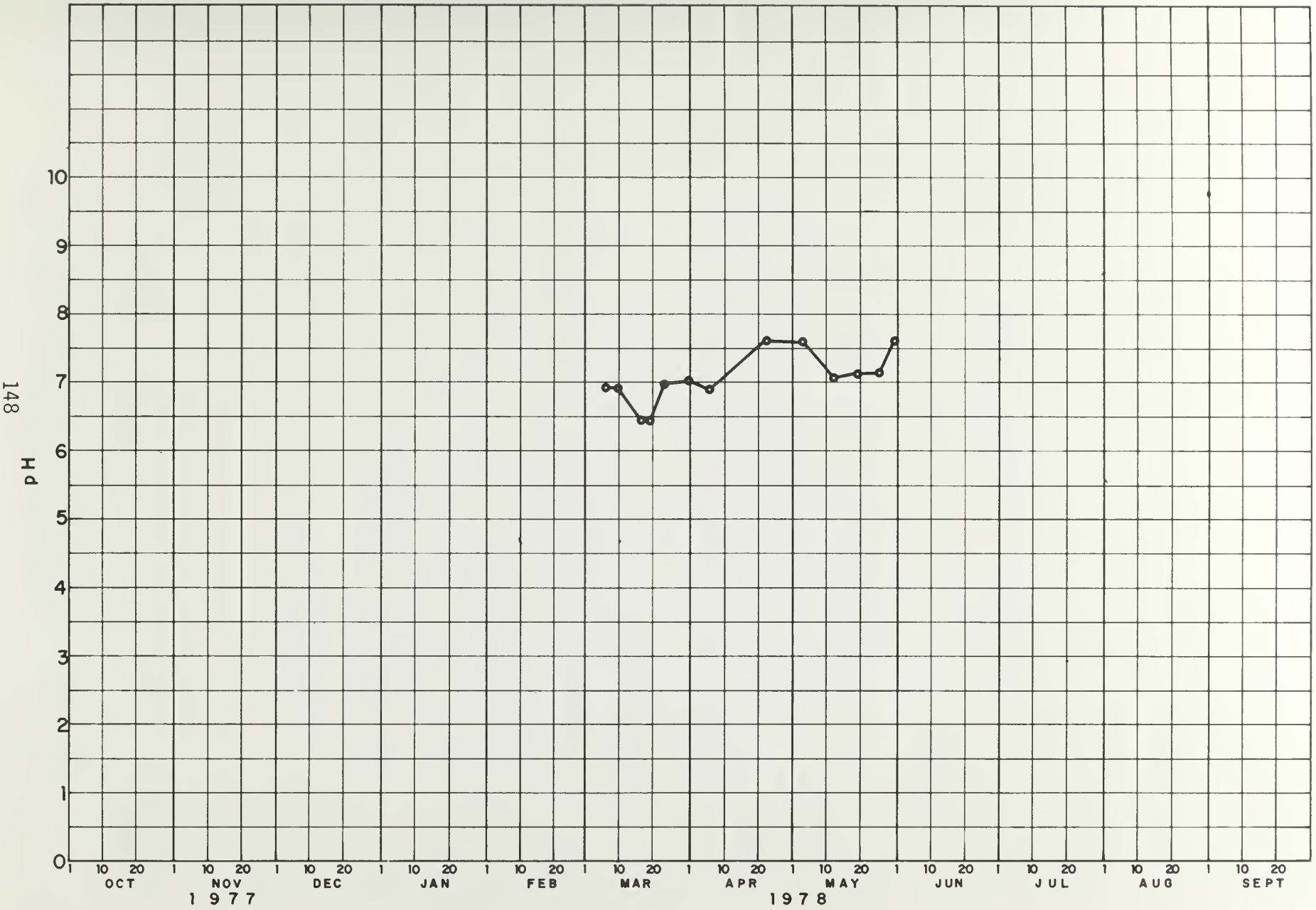


Figure 5-39. pH at Alluvial Hole GS S-24, 5 March to 31 May.

Note that no water was measured in GS S-27a until May 11, and the water quality in that hole varies considerably from GS S-27, which is just across Corral Gulch.

C. Deep Groundwater

1. Objectives

The objective of monitoring the deep oil shale aquifers during the pump test is to determine the effect of the pumping on the water level in these aquifers.

2. Methods

Static water levels were measured in five upper deep oil shale aquifer monitor holes and one lower oil shale monitor hole for three days prior to the start-up of the pump. After the pumps were turned on, the upper and lower aquifer holes were monitored once daily for two to three days. After trends were established, this monitoring frequency was reduced to once weekly.

3. Results and Discussion

Water levels measured from 25 February through 31 May are shown on Figures 5-40 through 5-44 and Table 5-14. Water levels in the upper aquifer of GS M-1, GS M-2, and GS M-4, and GS 15 show a downward trend. This trend began concurrently with the start of the dewatering pumps, GS M-1 dropped approximately 5 feet, GS M-2 1.4 feet, GS M-4 8 feet, and GS 15 dropped approximately 2 feet. The water level in the upper aquifer of GS 11 rose approximately 1 foot; and the water level in the lower aquifer of GS 15 rose approximately 1.3 feet.

D. Erosion and Sedimentation Stations

1. Objectives

The objective of monitoring the erosion and sedimentation stations is to monitor changes in the stream channel due to pump test discharges.

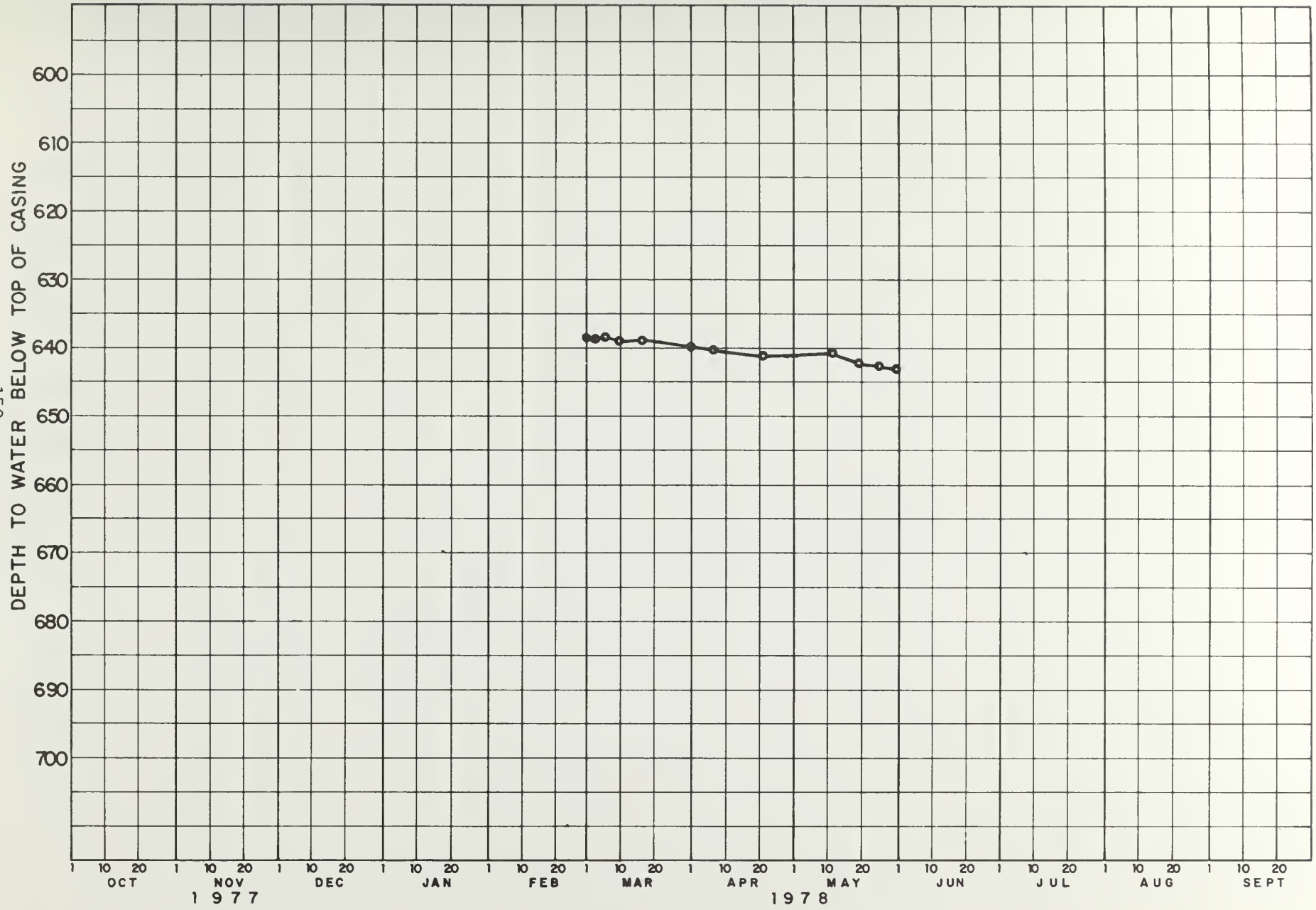


Figure 5-40. Depth to Water, 1 March to 31 May, Deep Aquifer Hole GS M-1.

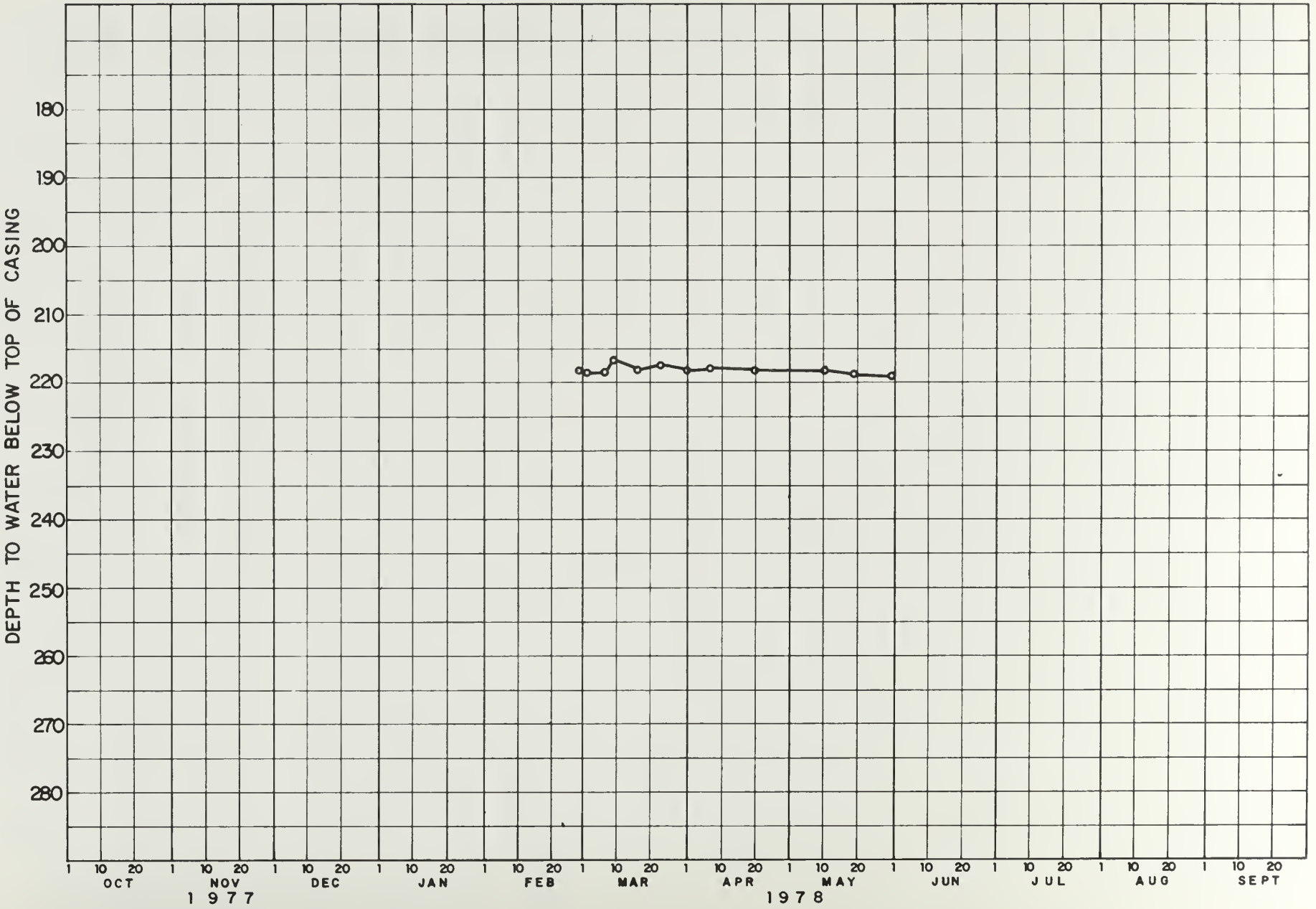


Figure 5-41. Depth to Water, 25 February to 31 May, Deep Aquifer Hole GS M-2.

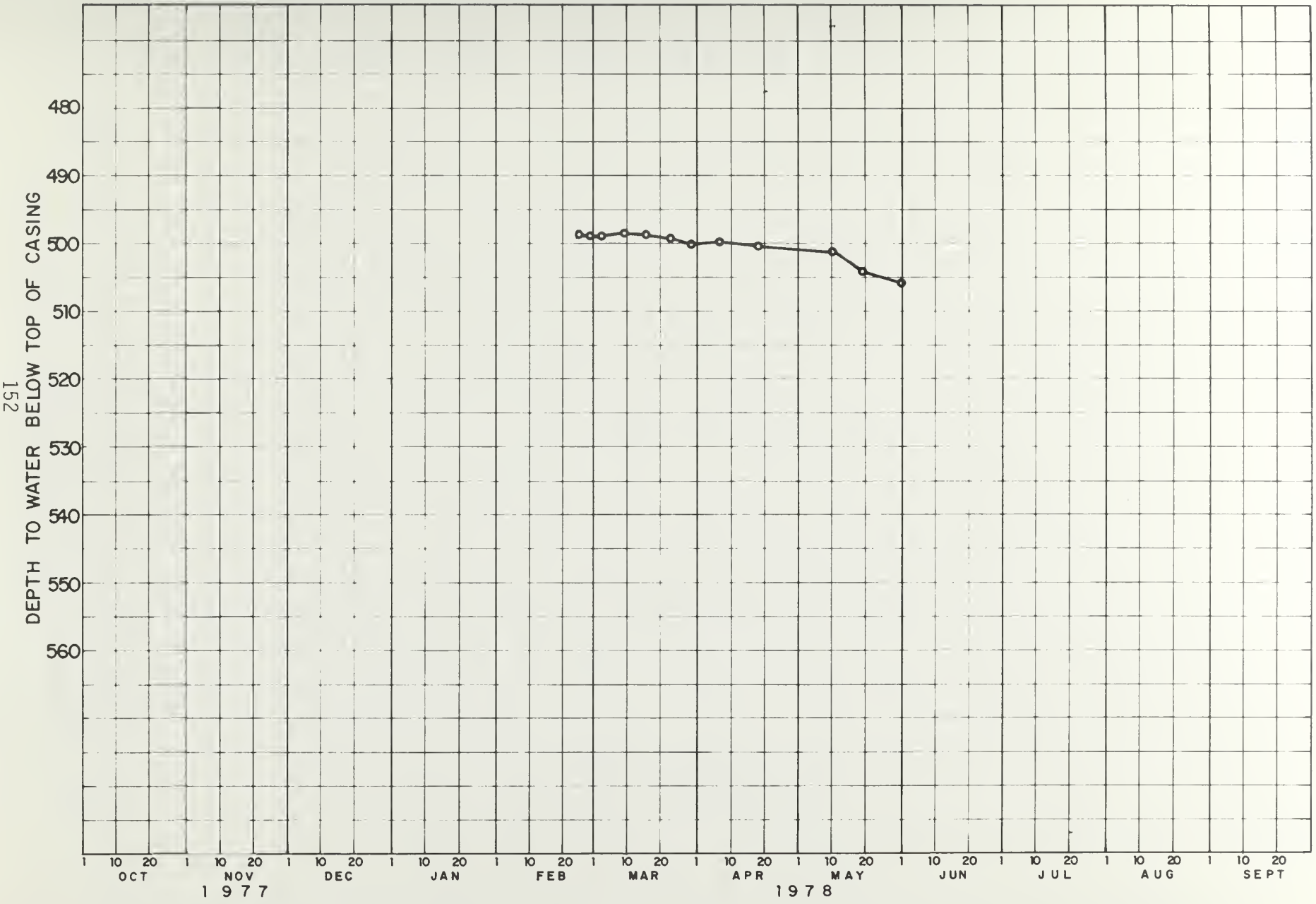


Figure 5-42. Depth to Water, 25 February to 31 May, Deep Aquifer Hole GS M-4.

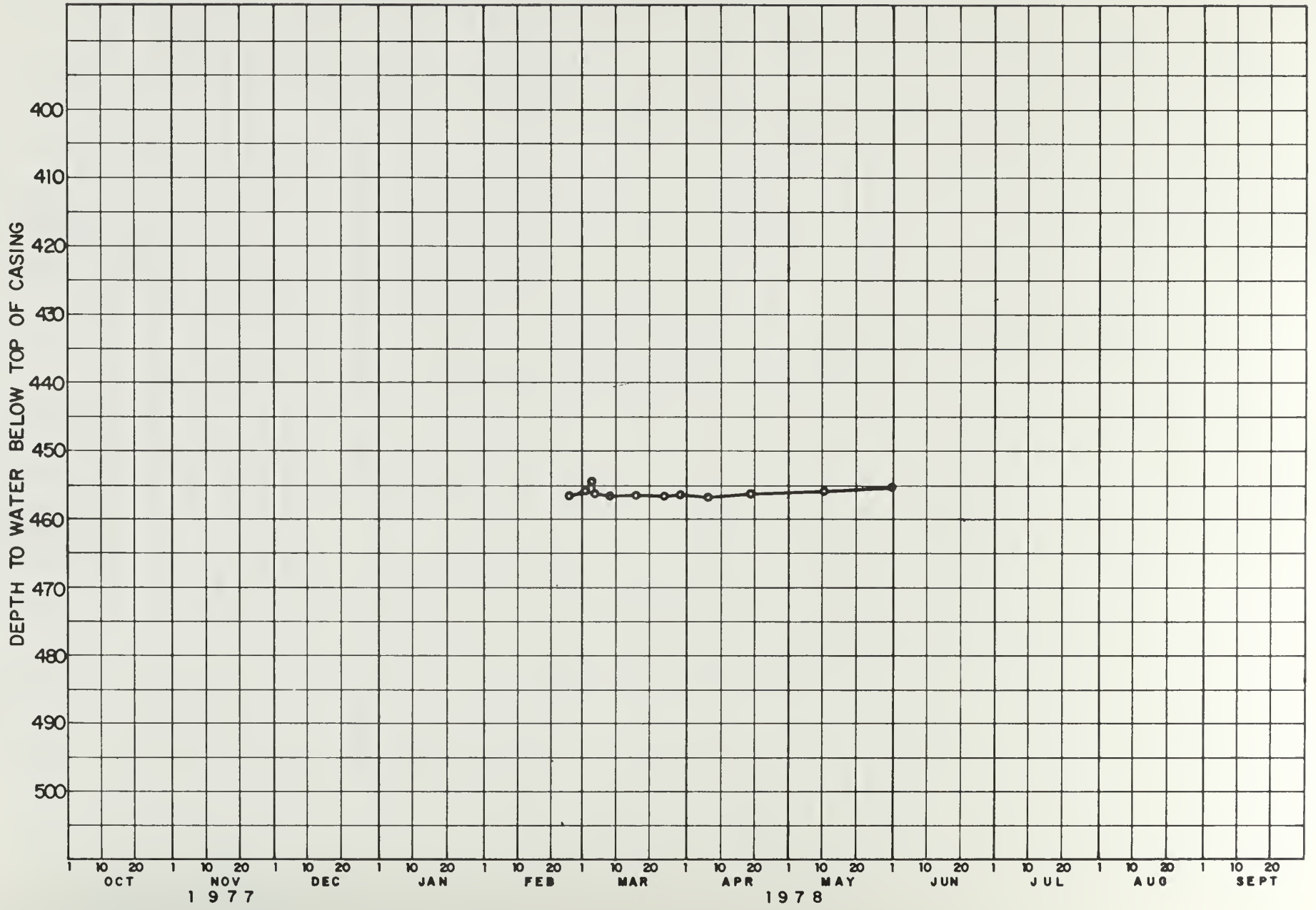


Figure 5-43. Depth to Water, 25 February to 31 May, Deep Aquifer Hole GS 11.

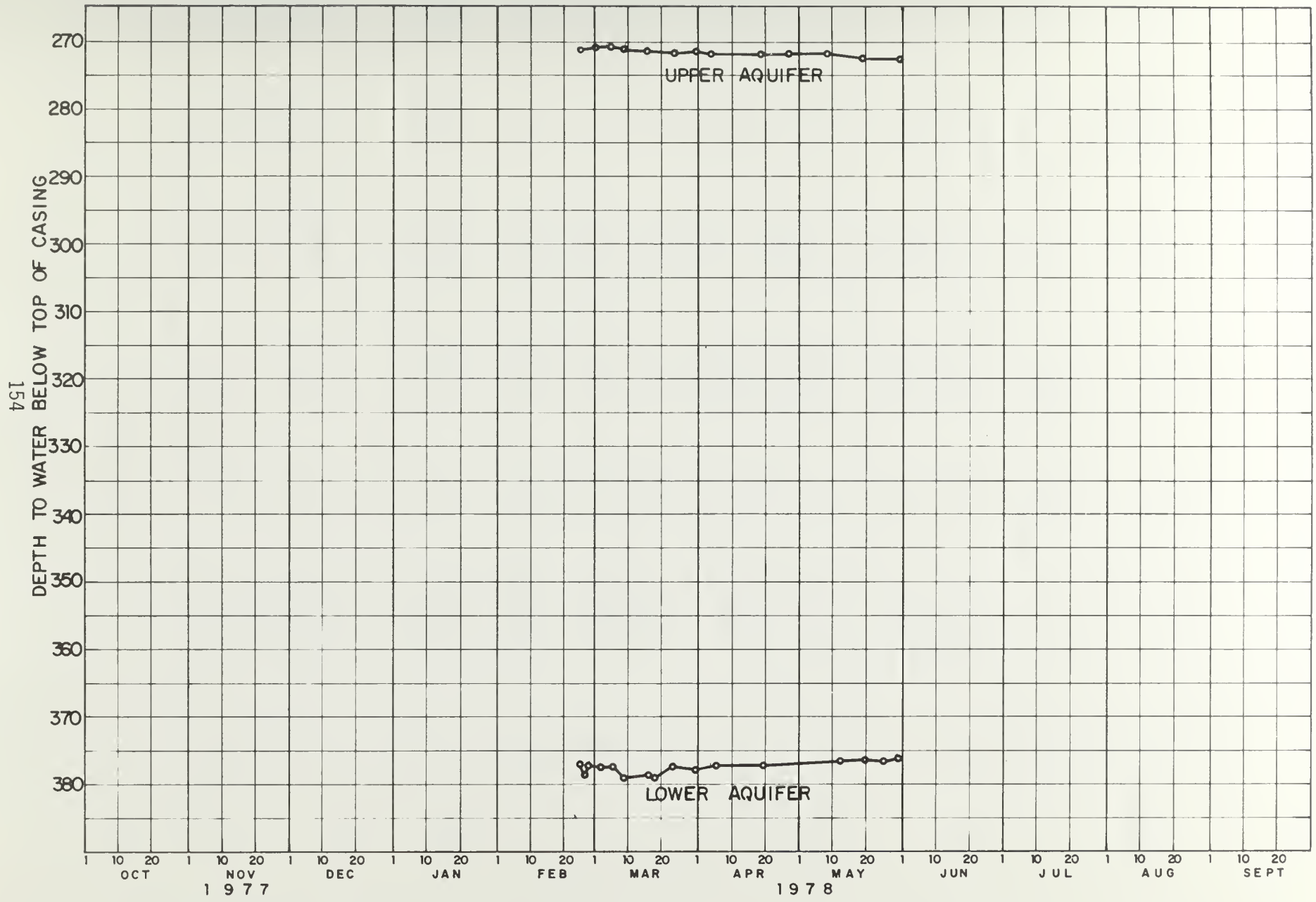


Figure 5-44. Depth to Water, 25 February to 31 May, Deep Aquifer Hole GS 15, Upper and Lower Aquifer.

Table 5-14. Deep Aquifer Water Levels, Below Ground Surface in Feet, 25 February to 31 May.

		GS M-1	GS M-2	GS M-4	GS 11	GS 15 Lower	GS 15 Upper
February	25				456.11	377.26	271.04
	26					378.28	
	27		217.67	498.16		377.21	
	28		217.70	498.42	456.03	377.36	271.04
March	1	637.39	217.64	498.29	455.96	377.32	270.91
	2	638.02	217.84	498.49	454.97	377.39	271.03
	4	638.06	218.07	498.45	456.20	377.46	371.13
	5				456.03	377.43	271.09
	6	637.65	218.11	498.56	456.18	377.72	271.14
	7		217.97	498.56	456.36	377.94	271.23
	8		217.54	498.49	456.40	378.11	271.36
	9	638.39	217.22	498.37	456.30	378.18	271.39
	10		216.92	498.31	456.10	378.02	271.23
	15	638.80	217.40	498.38	456.39	377.75	271.51
	16	638.93	217.62	498.41	456.47	377.87	271.62
	17	638.79	217.61	498.39	456.46	377.87	271.51
	24		217.44	499.40	456.26	377.37	271.40
	30	639.53	217.50	500.01	456.19	377.31	271.41
April	6	640.04	217.70	499.87	456.06	377.04	271.48
	19	640.65	217.80	500.92	455.97	376.97	271.71
May	3						
	11	640.30	218.03	502.93	455.46	376.45	272.00
	18	642.10	218.98	504.69	455.30	376.41	272.35
	25	642.44				376.24	272.58
	31	642.73	219.08	506.09	455.11	376.00	272.75

2. Methods

A total of 16 erosion and sedimentation stations has been constructed. The channel profile is identified at each of these stations by taking channel depth measurements to the nearest 1/2-inch every 6 inches across the stream channel. The channel width of the stations are sufficient to contain all anticipated flows. In addition, photographs are taken both upstream and downstream from the point of the profile. Additional sections are measured two times a month.

3. Results and Discussion

The earliest and latest stream channel profiles taken at the erosion stations are displayed on Figures 45a through 58b. The only stations not constructed by the end of this reporting period were #1, #14, and #16 (these stations were constructed June 12). Station #2, just below the settling pond at the mine site, was destroyed in May by activities at the mine site.

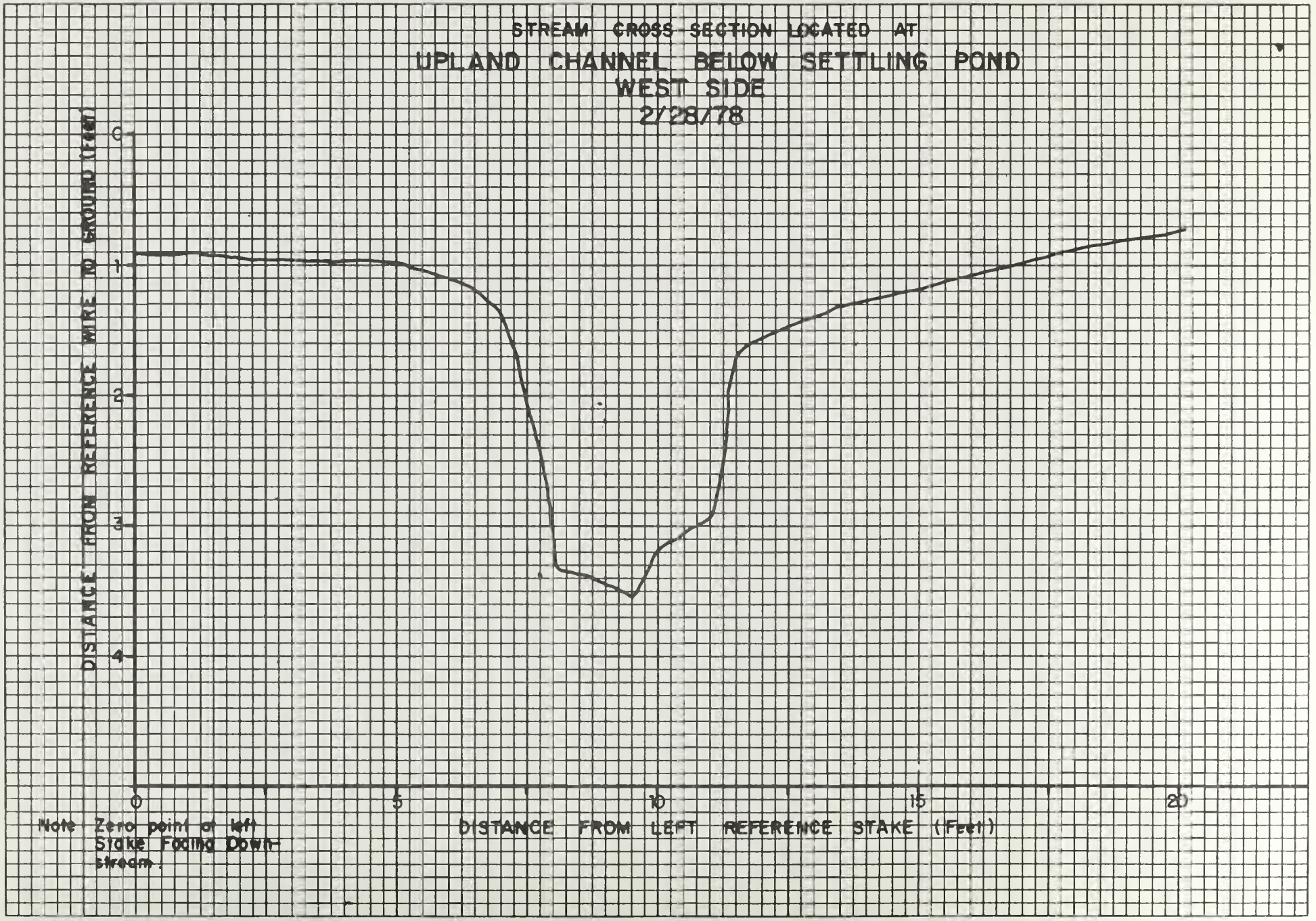


Figure 5-45a. Stream Channel Profile of Upland Channel Below Settling Pond, West Side, 28 February.

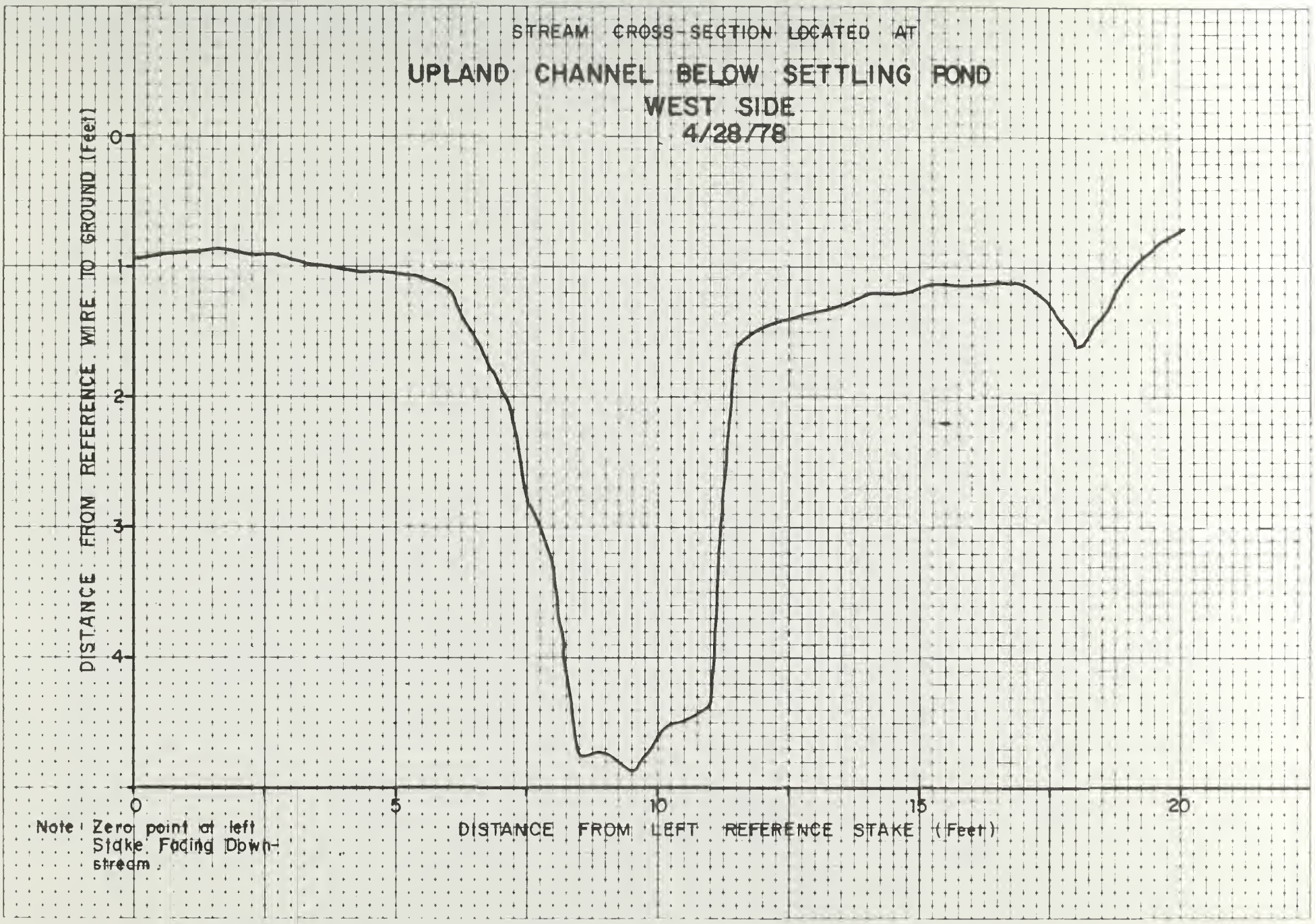


Figure 5-45b. Stream Channel Profile of Upland Channel Below Settling Pond, West Side, 28 April.

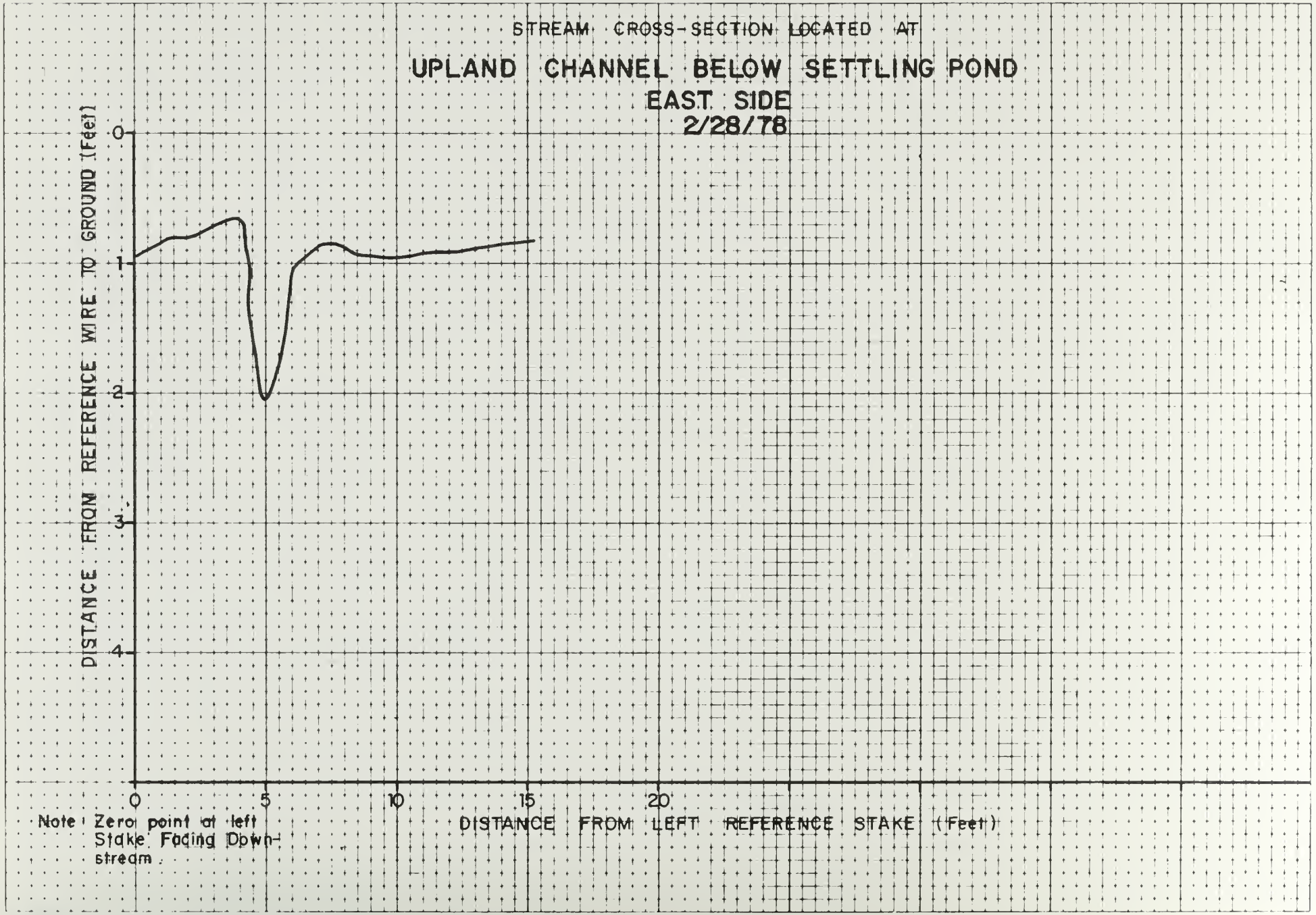


Figure 5-46a. Stream Channel Profile of Upland Channel Below Settling Pond, East Side, 28 February.

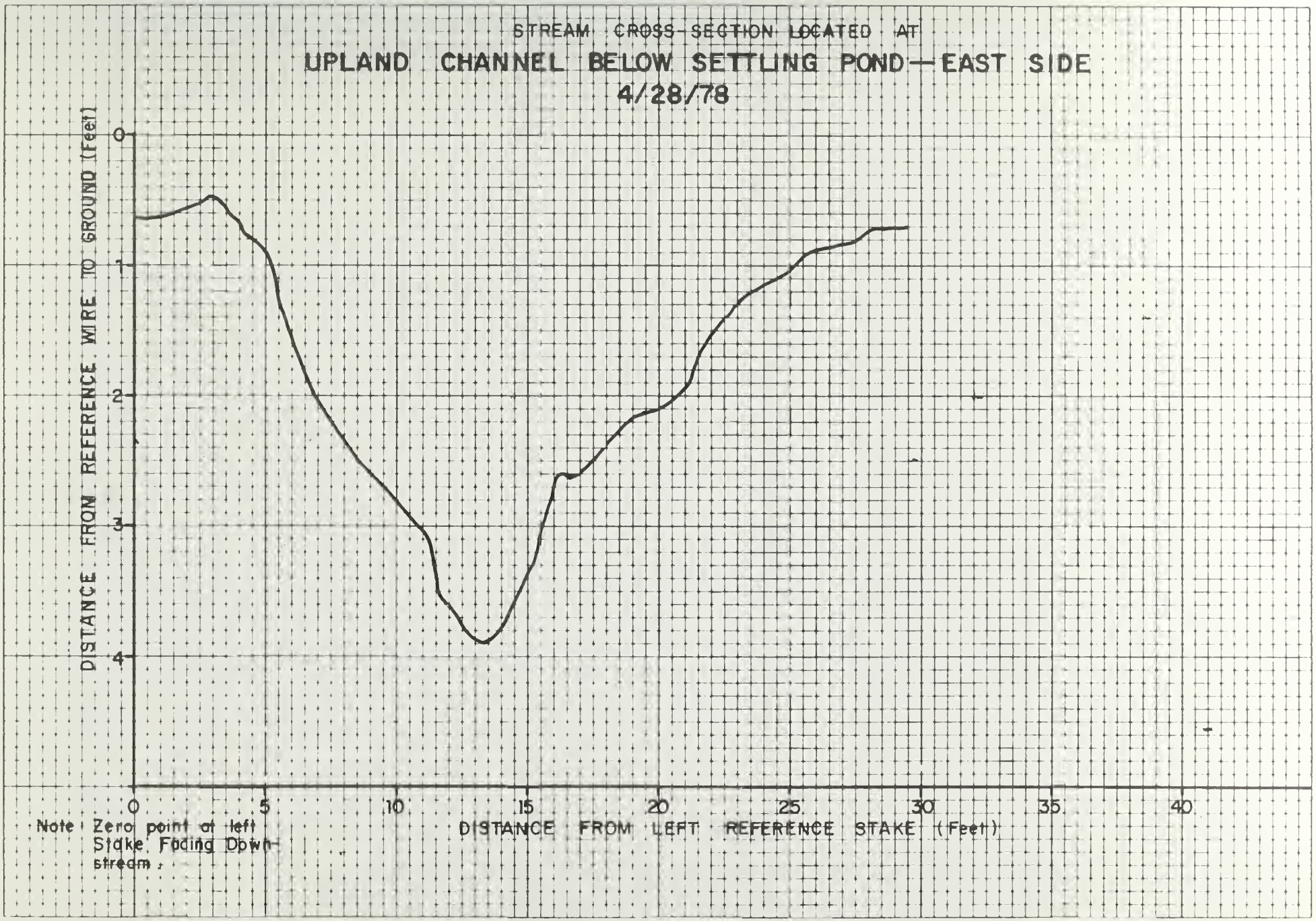


Figure 5-46b. Stream Channel Profile of Upland Channel Below Settling Pond, East Side, 28 April.

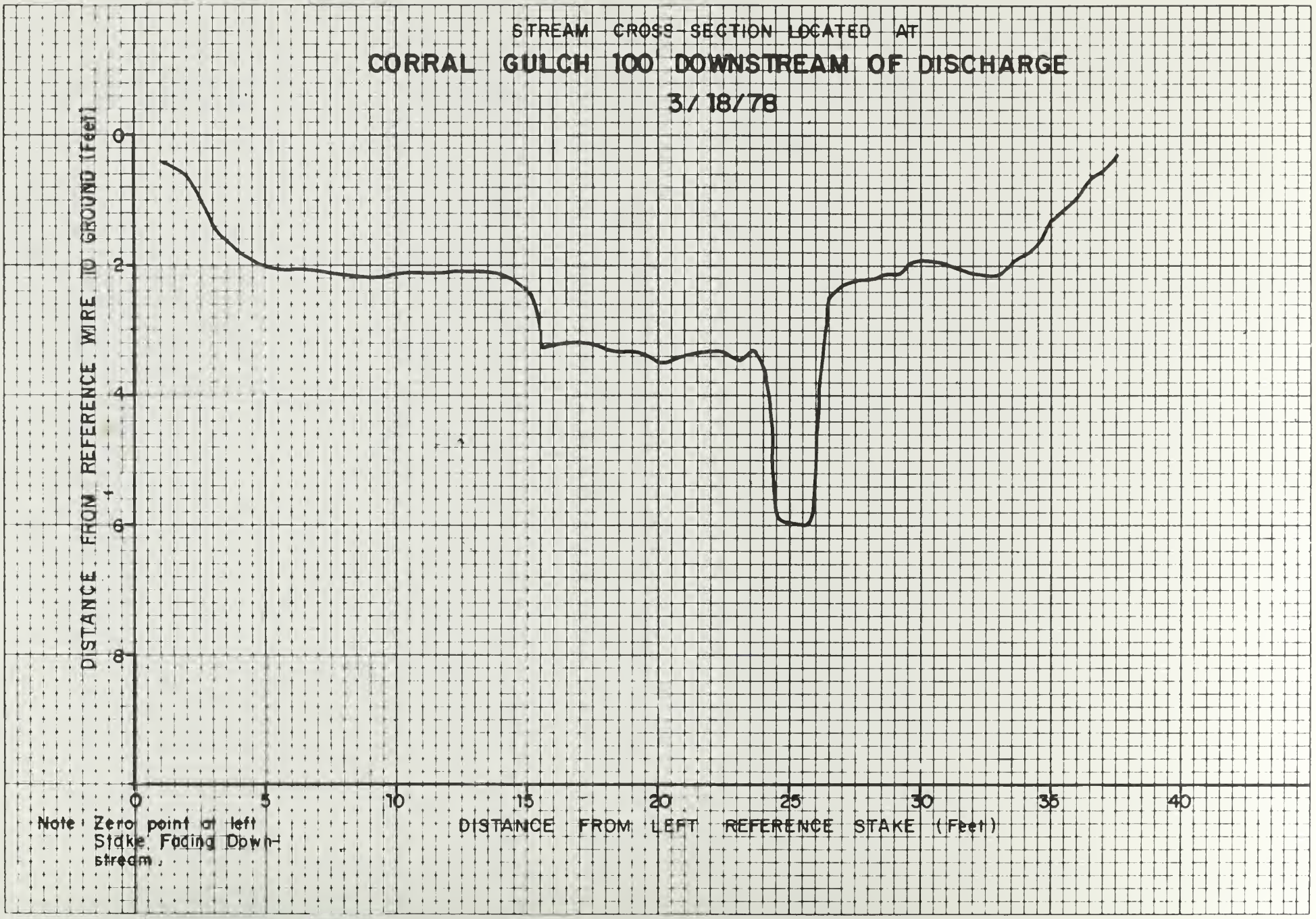


Figure 5-47a. Stream Channel Profile of Corral Gulch 100 Feet Downstream of Discharge, 18 March.

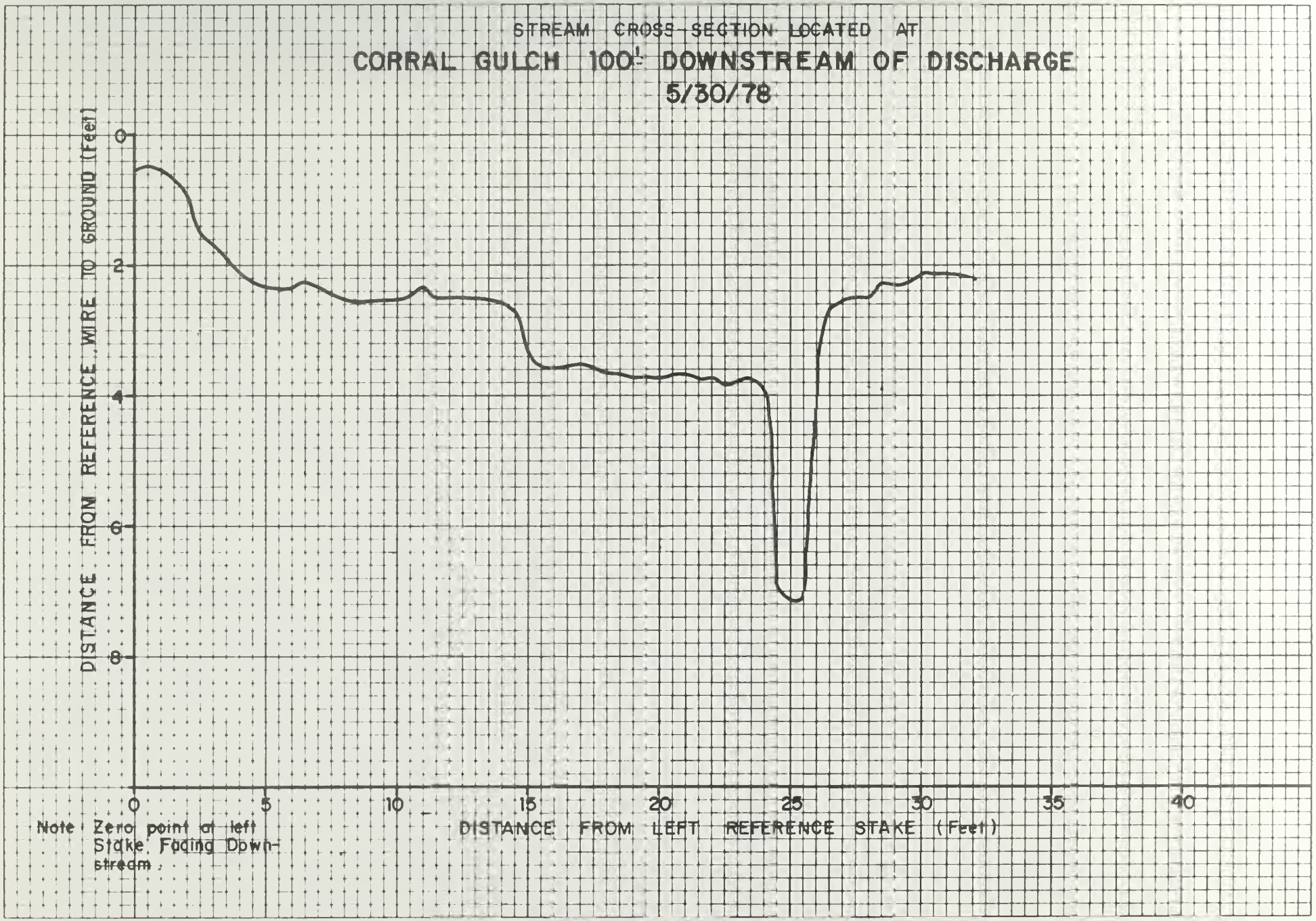


Figure 5-47b. Stream Channel Profile of Corral Gulch 100 Feet Downstream of Discharge, 30 May.

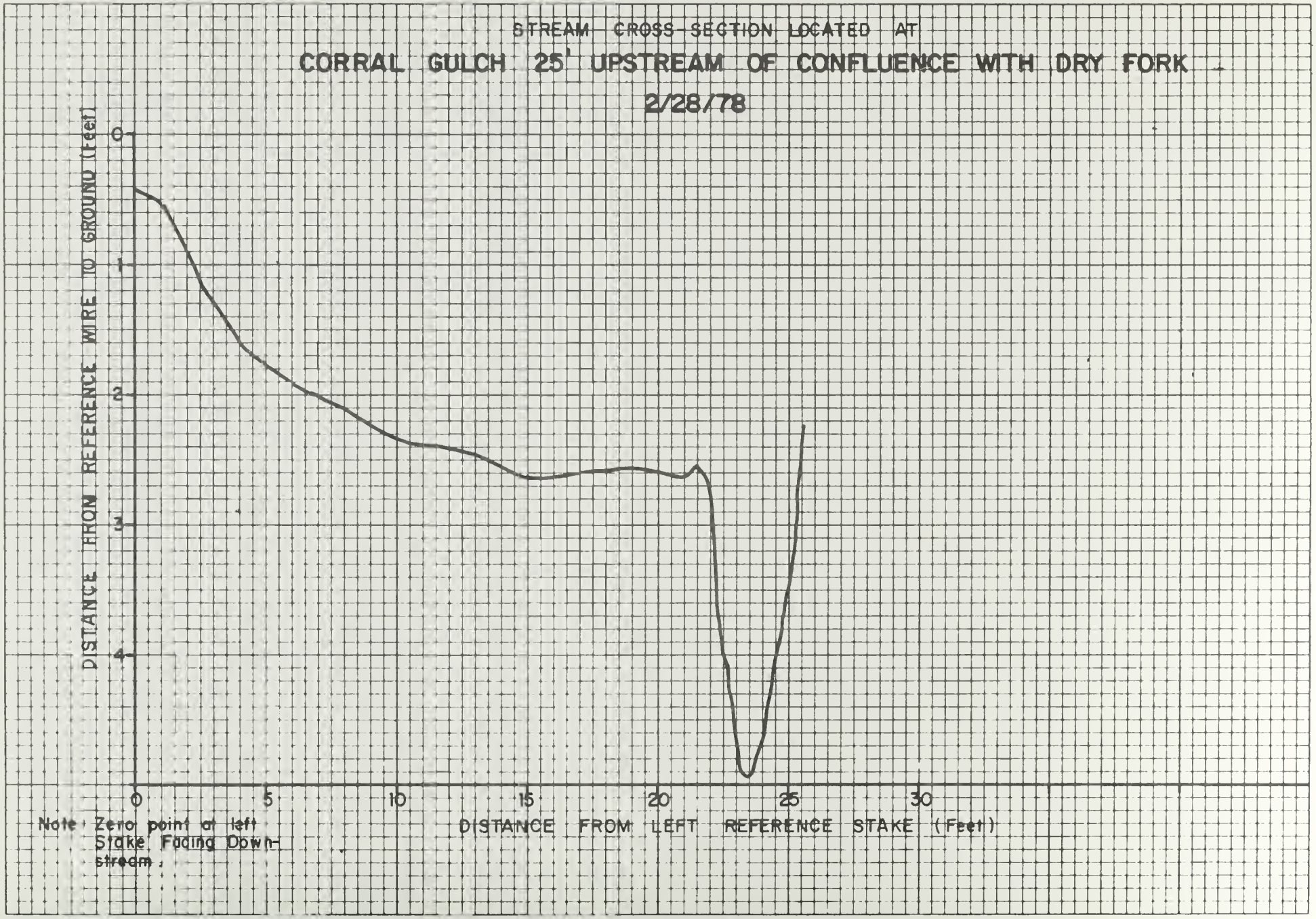


Figure 5-48a. Stream Channel Profile of Corral Gulch 25 Feet Upstream of Confluence with Dry Fork, 28 February

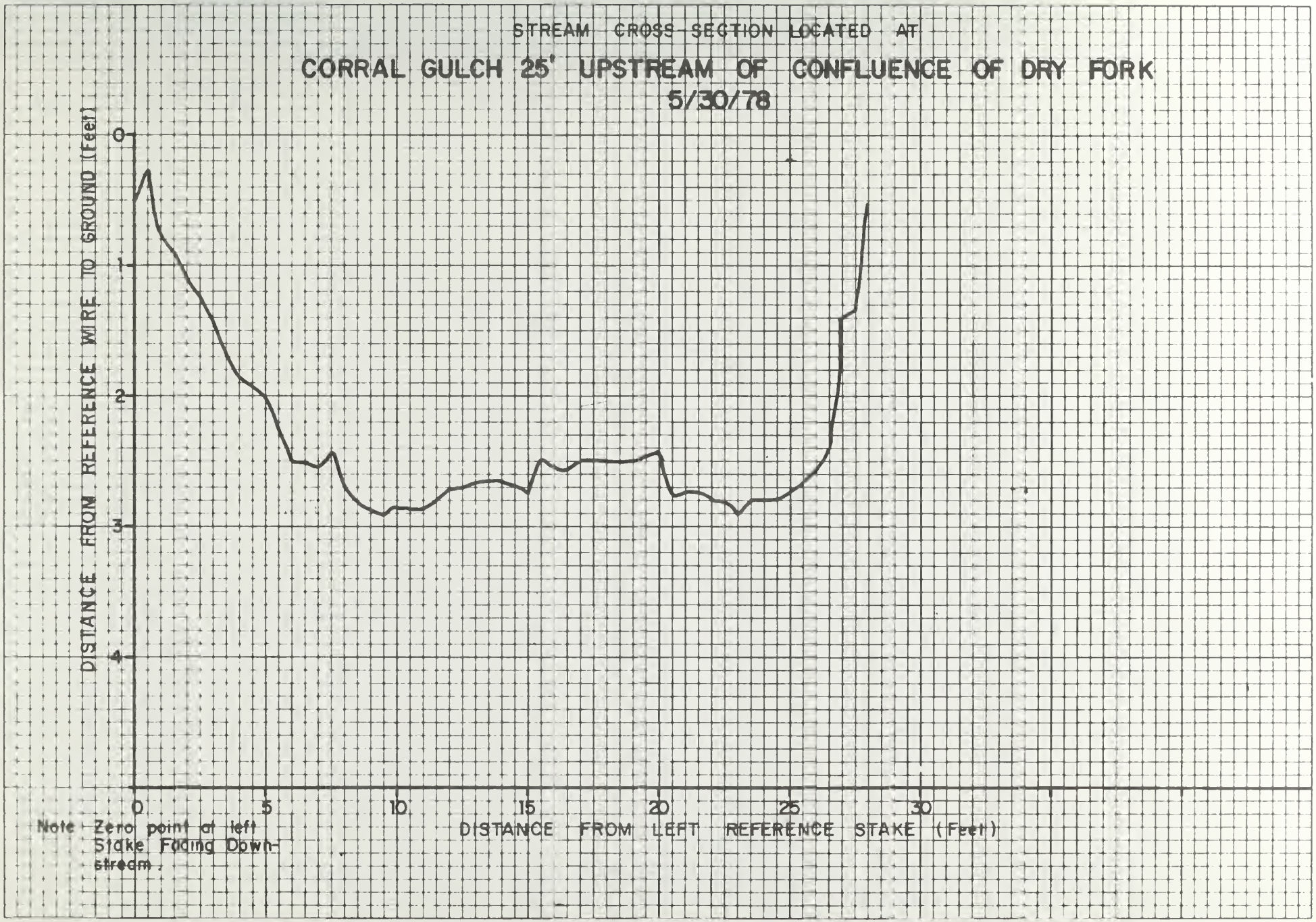


Figure 5-48b. Stream Channel Profile of Corral Gulch 25 Feet Upstream of Confluence with Dry Fork, 30 May.

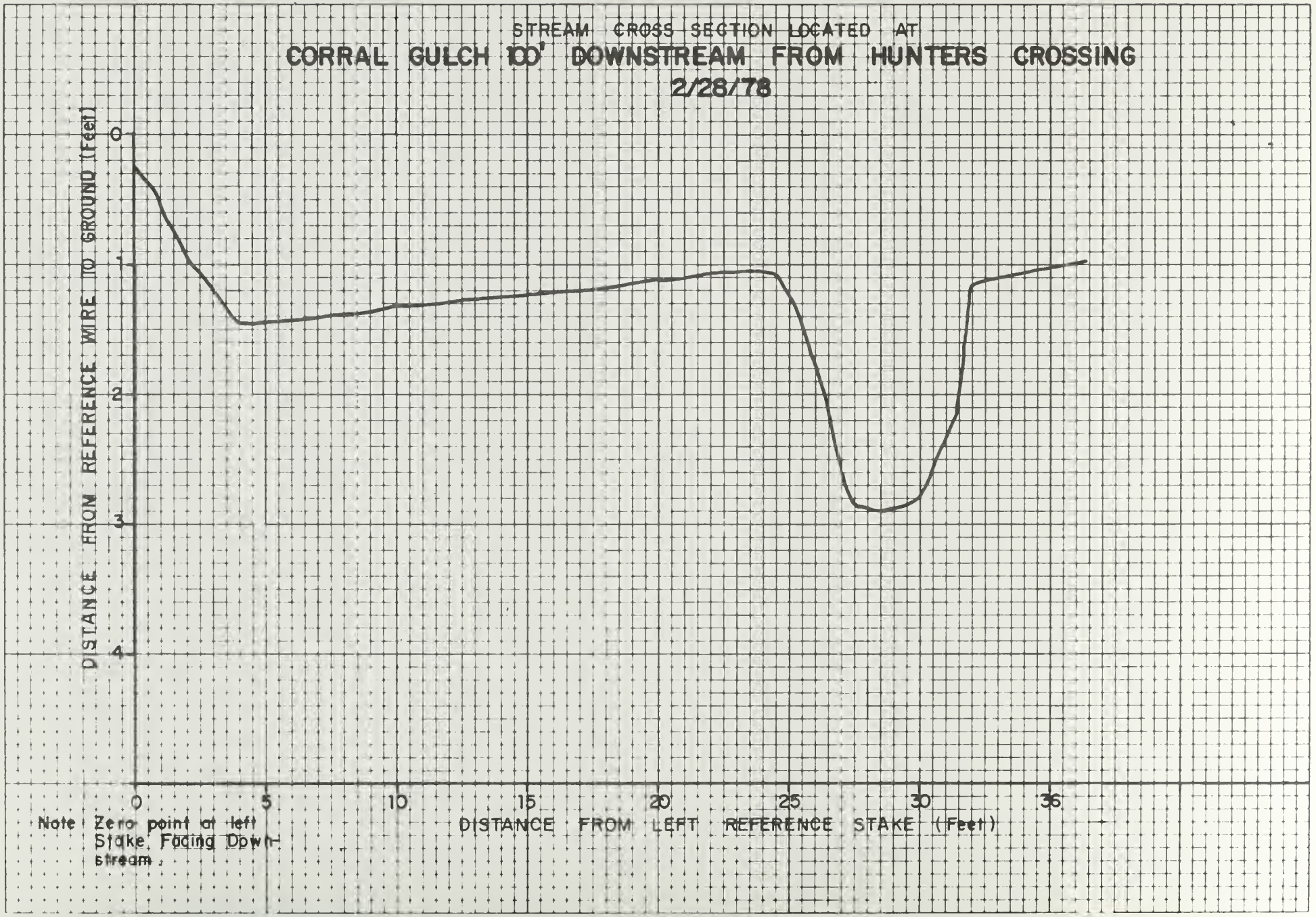


Figure 5-49a. Stream Channel Profile of Corral Gulch 100 Feet Downstream form Hunters Crossing, 28 February.

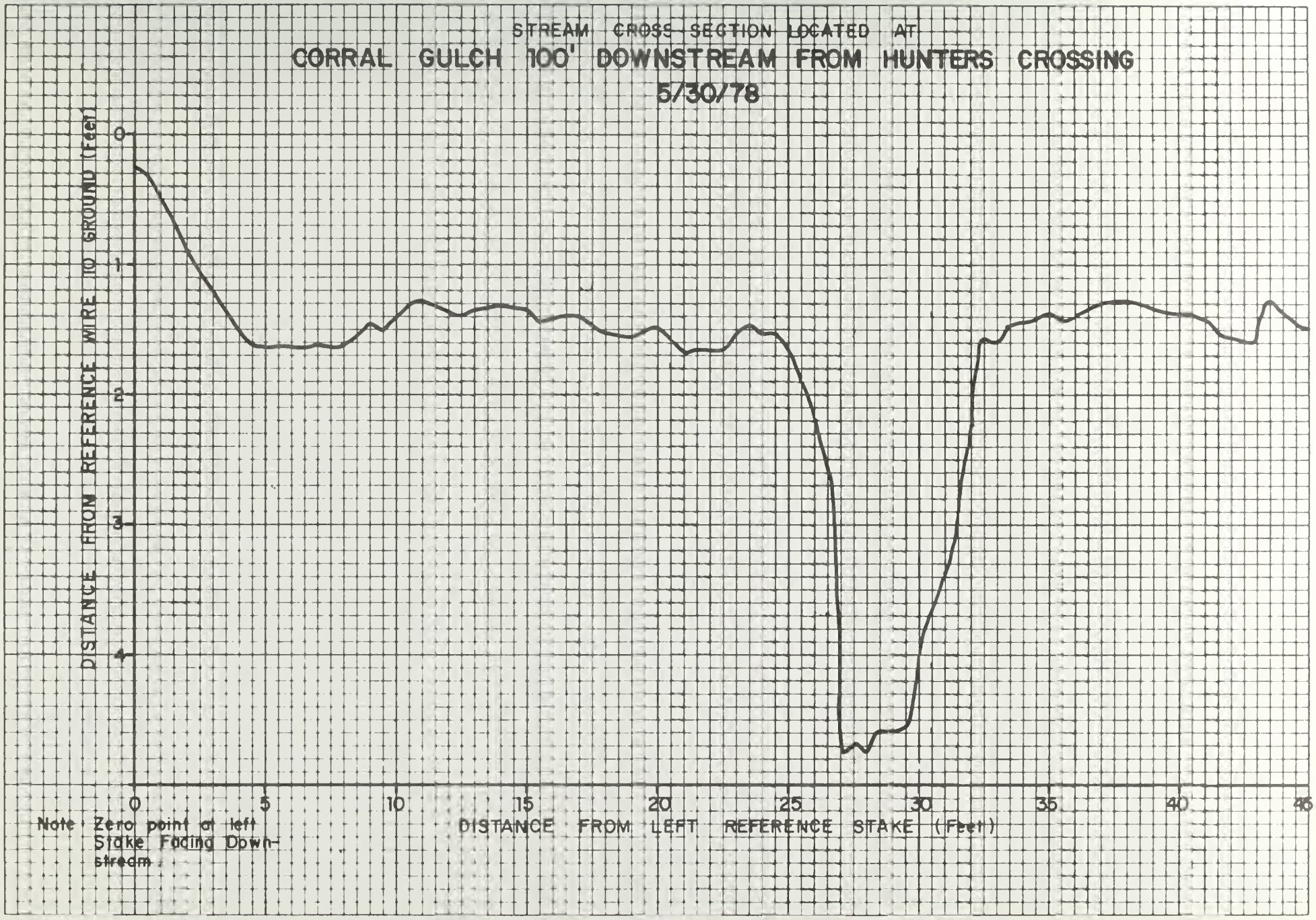


Figure 5-49b. Stream Channel Profile of Corral Gulch 100 Feet Downstream from Hunters Crossing, 30 May.

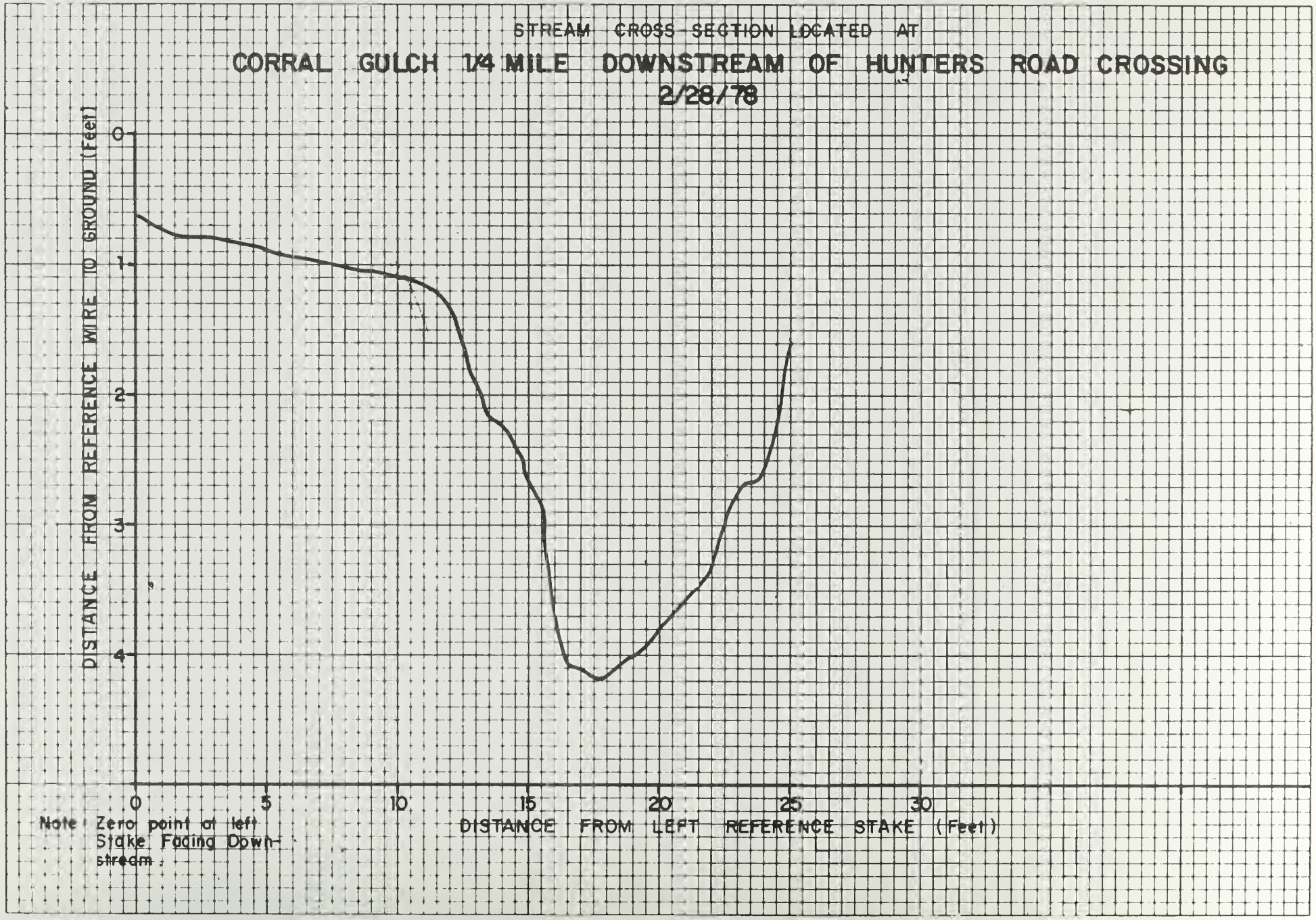


Figure 5-50. Stream Channel Profile of Corral Gulch 1/4 Mile Downstream of Hunters Road Crossing, 28 February.

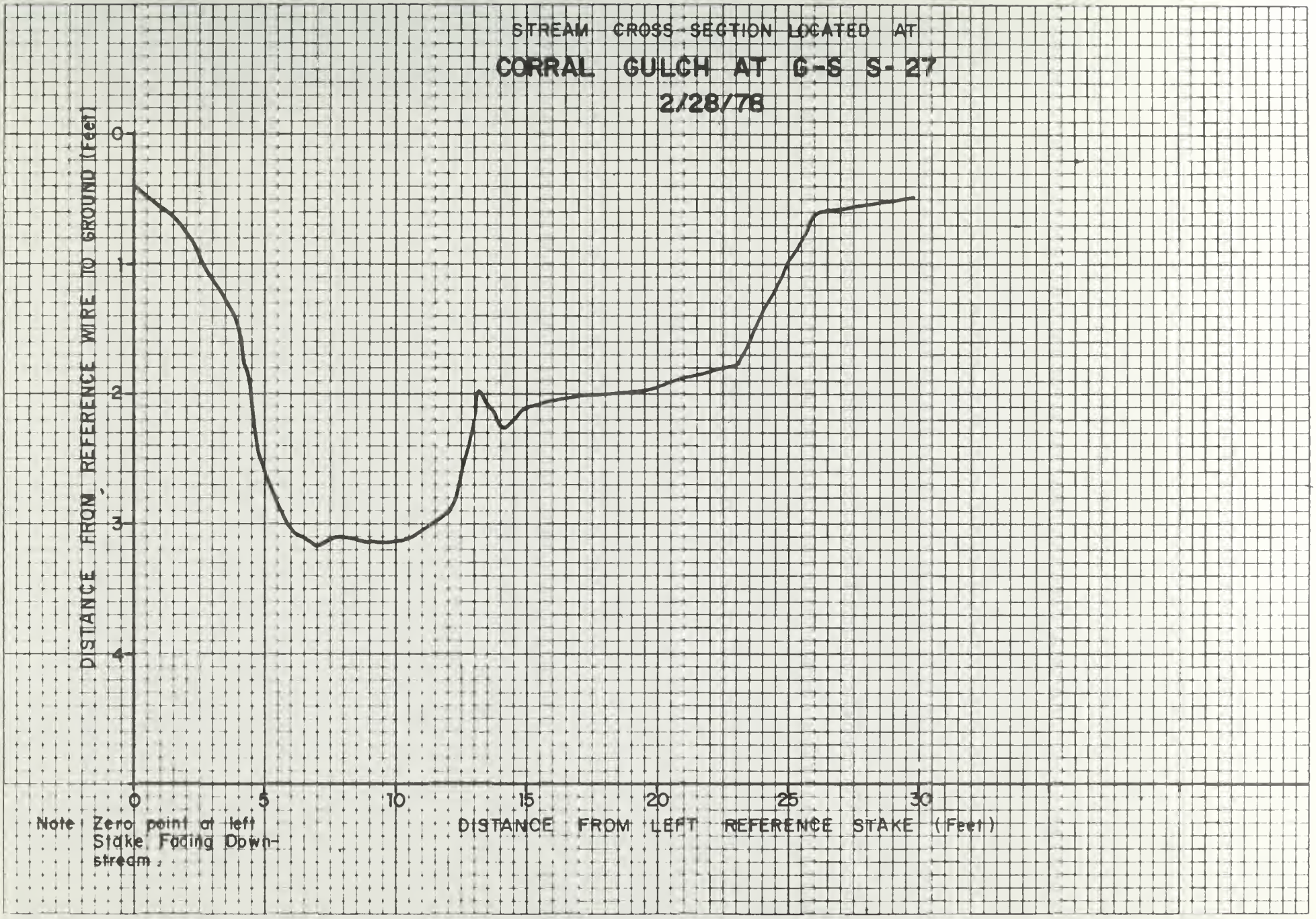


Figure 5-51a. Stream Channel Profile of Corral Gulch at GS S-27, 28 February.

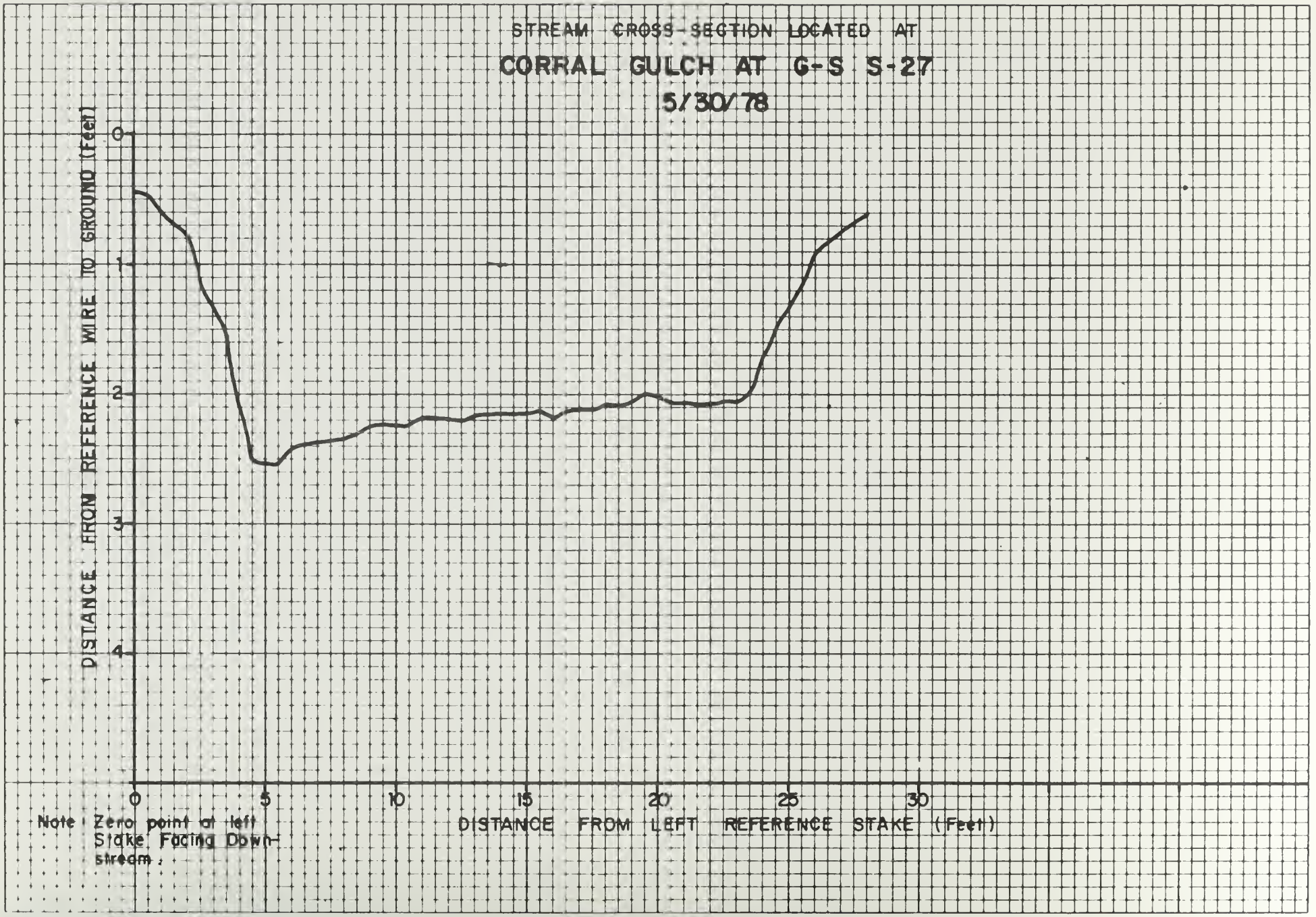


Figure 5-51b. Stream Channel Profile of Corral Gulch at GS S-27, 30 May.

Figure 5-52. Stream Channel Profile of Corral Gulch 300 Feet Downstream of USGS Gaging Station 09306242, 28 February.

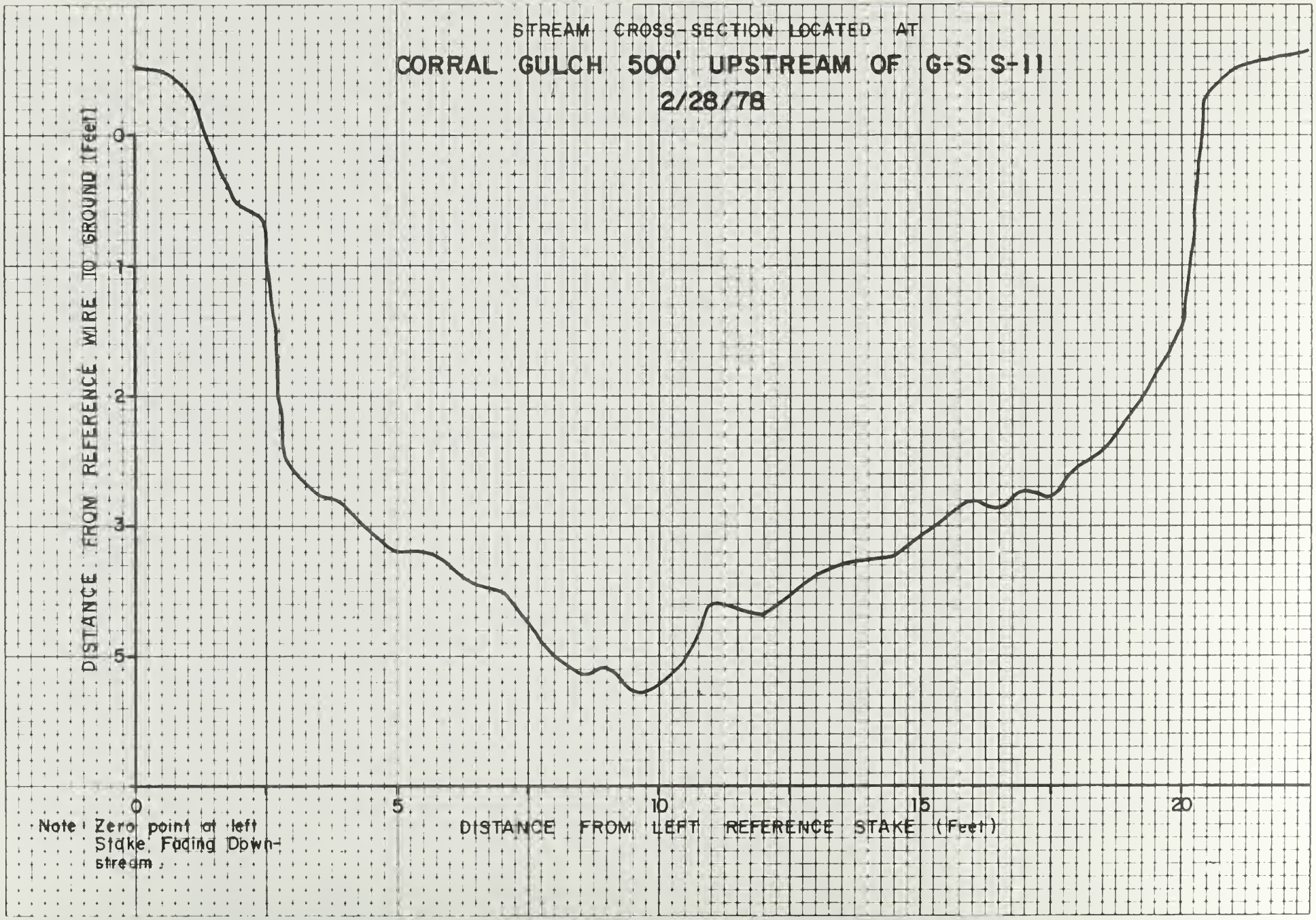


Figure 5-53a. Stream Channel Profile of Corral Gulch, 500 Feet Upstream of GS S-11,28 February.

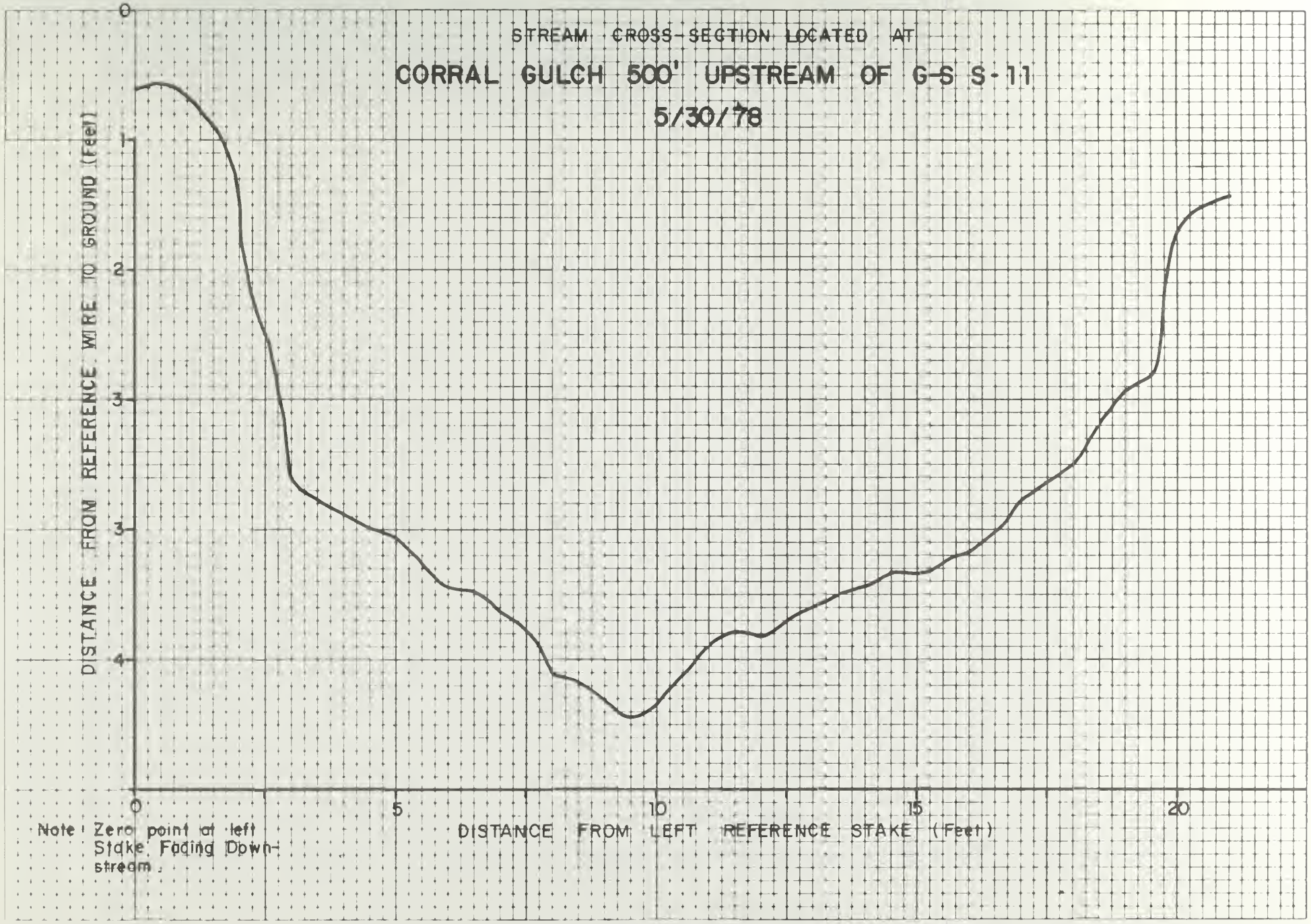


Figure 5-53b. Stream Channel Profile of Corral Gulch, 500 Feet Upstream of GS S-11, 30 May.

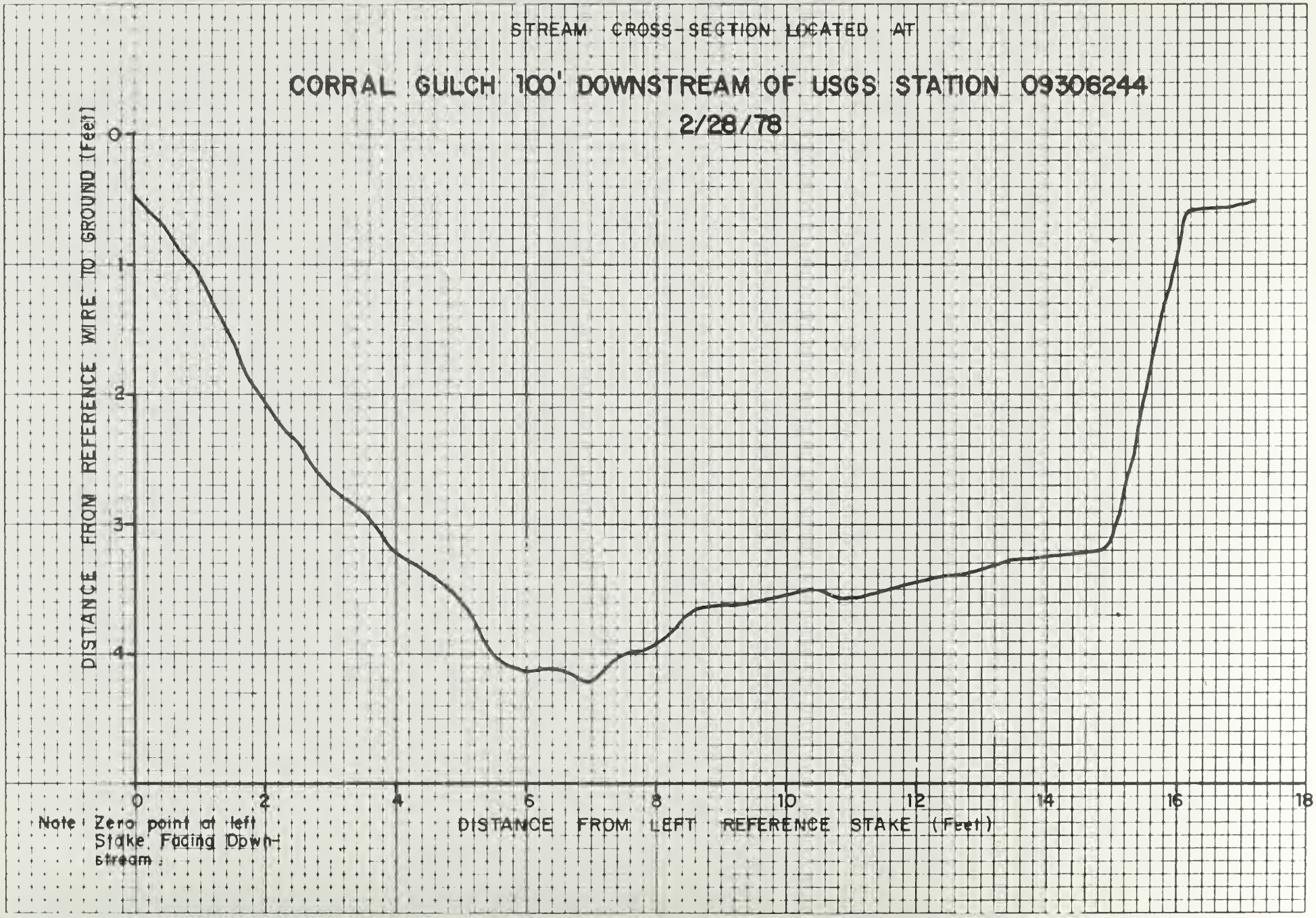


Figure 5-54a. Stream Channel Profile, Corral Gulch, 100 Feet Downstream of USGS Station 09306244, 28 February.

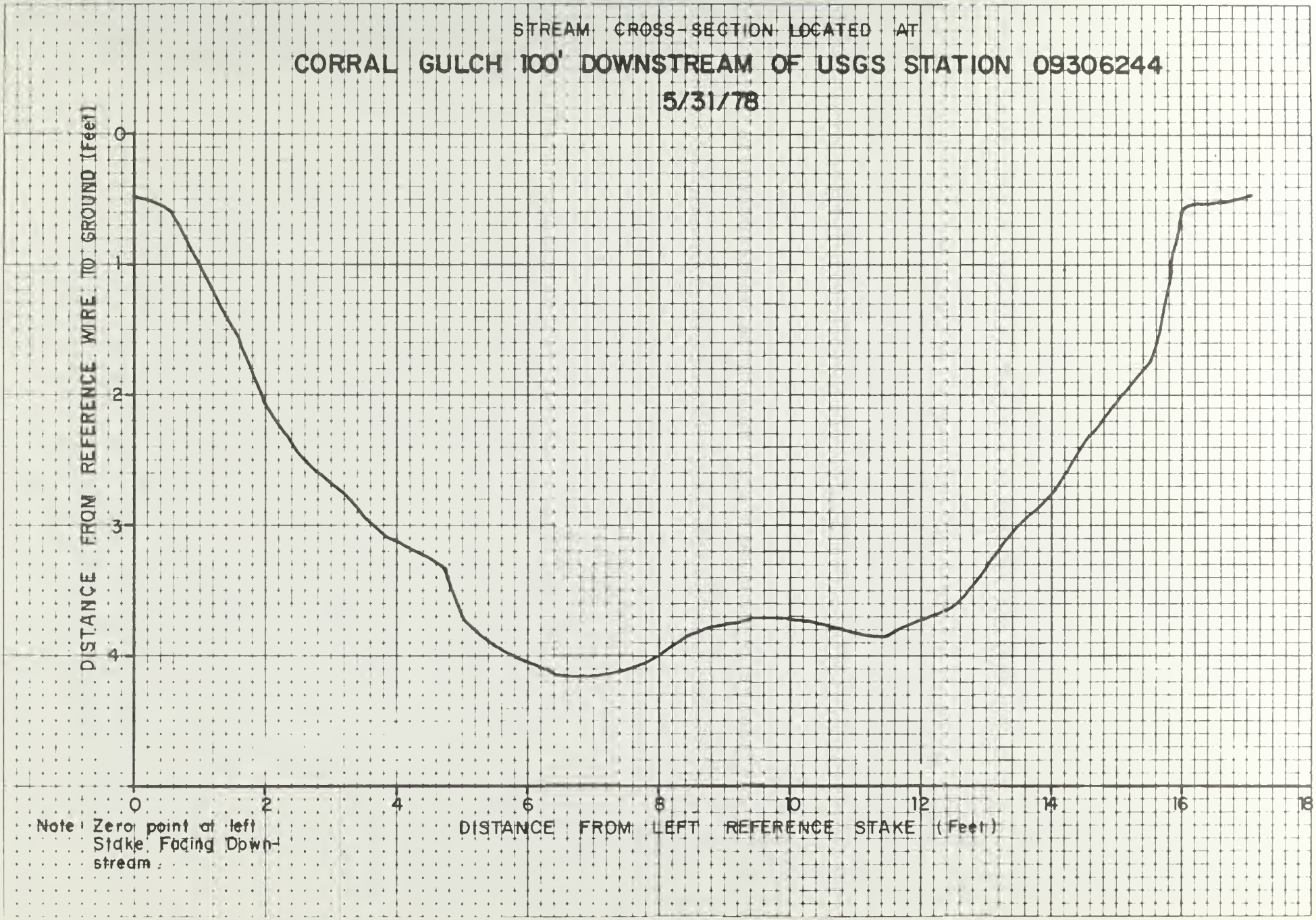


Figure 5-54b. Stream Channel Profile, Corral Gulch,100 Feet Downstream of USGS Station 09306244, 31 May

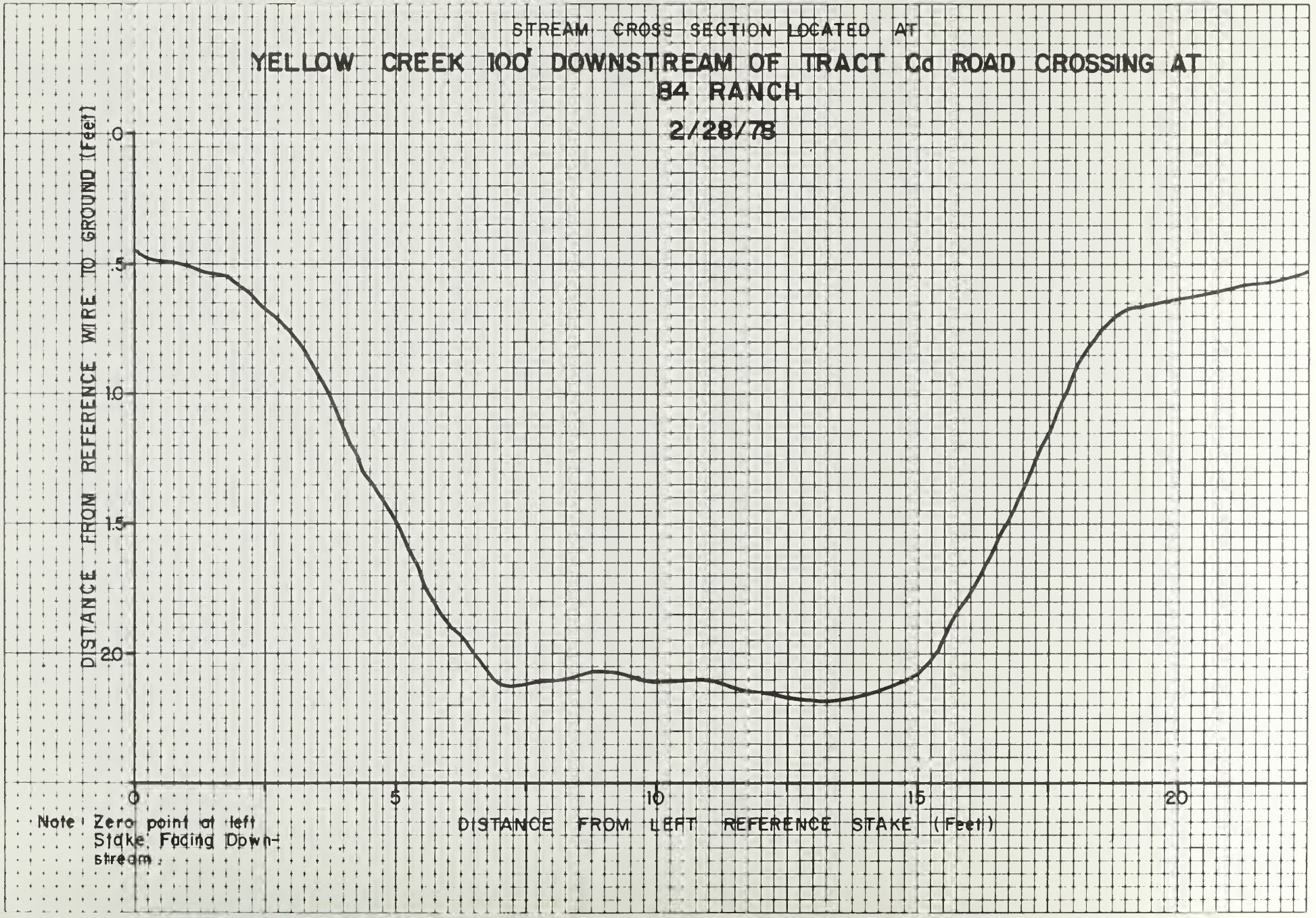


Figure 5-55. Stream Channel Profile of Yellow Creek, 100 Feet Downstream of Tract C-a Road Crossing at 84 Ranch, 28 February.

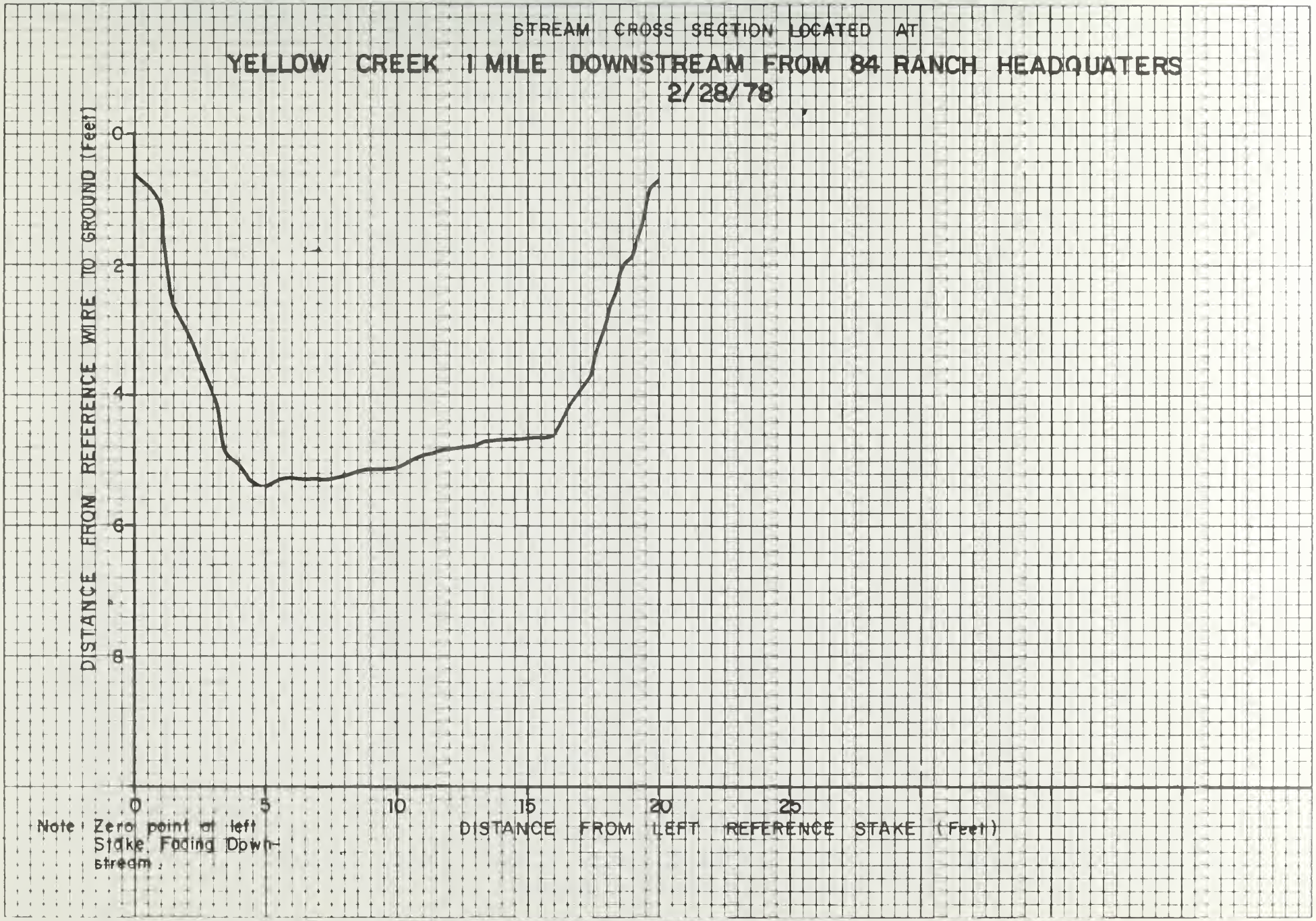


Figure 5-56a. Stream Channel Profile Yellow Creek 1 Mile Downstream from 84 Ranch Headquarters, 28 February.

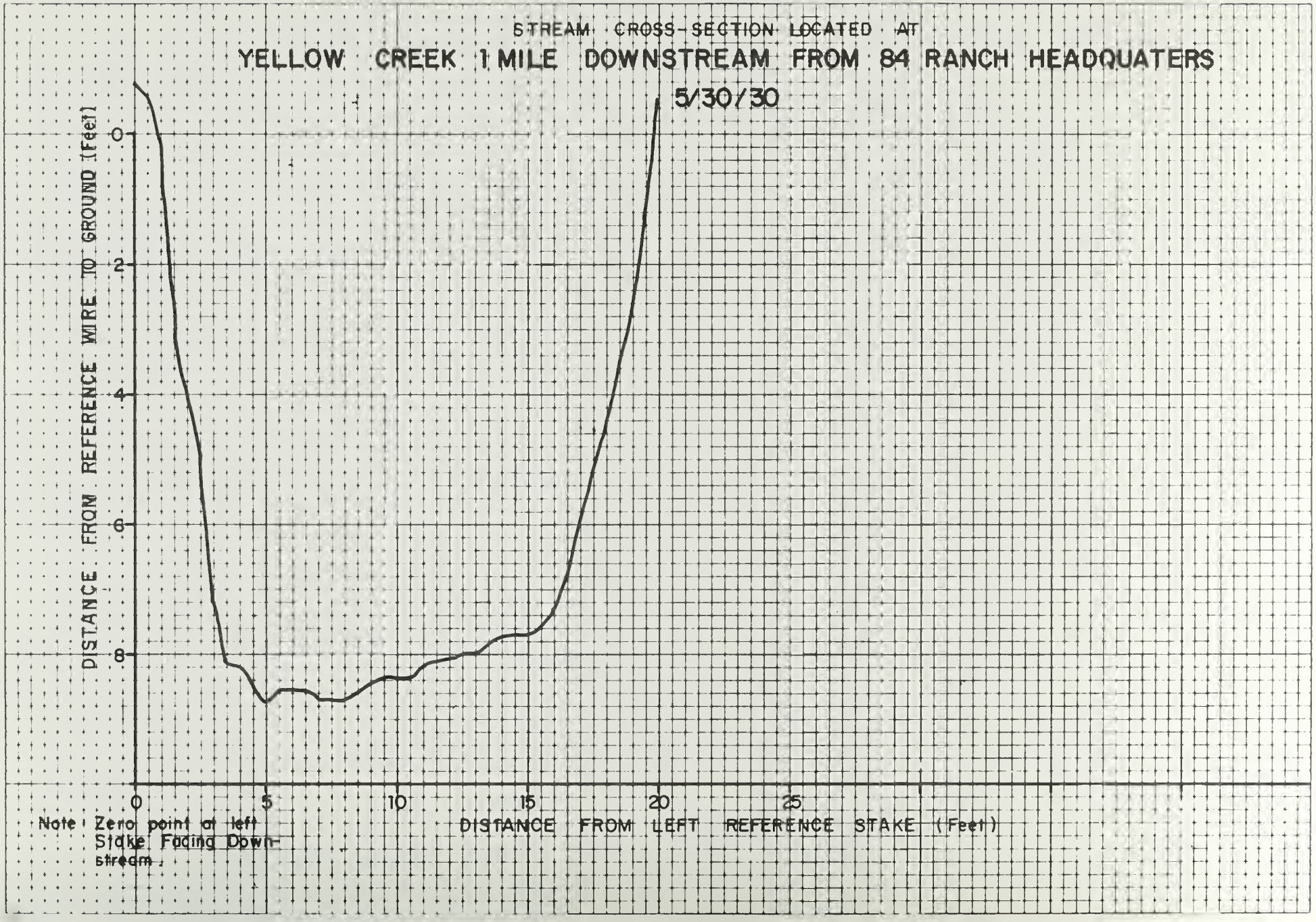


Figure 5-56b. Stream Channel Profile of Yellow Creek, 1 Mile Downstream from 84 Ranch Headquarters, 31 May.

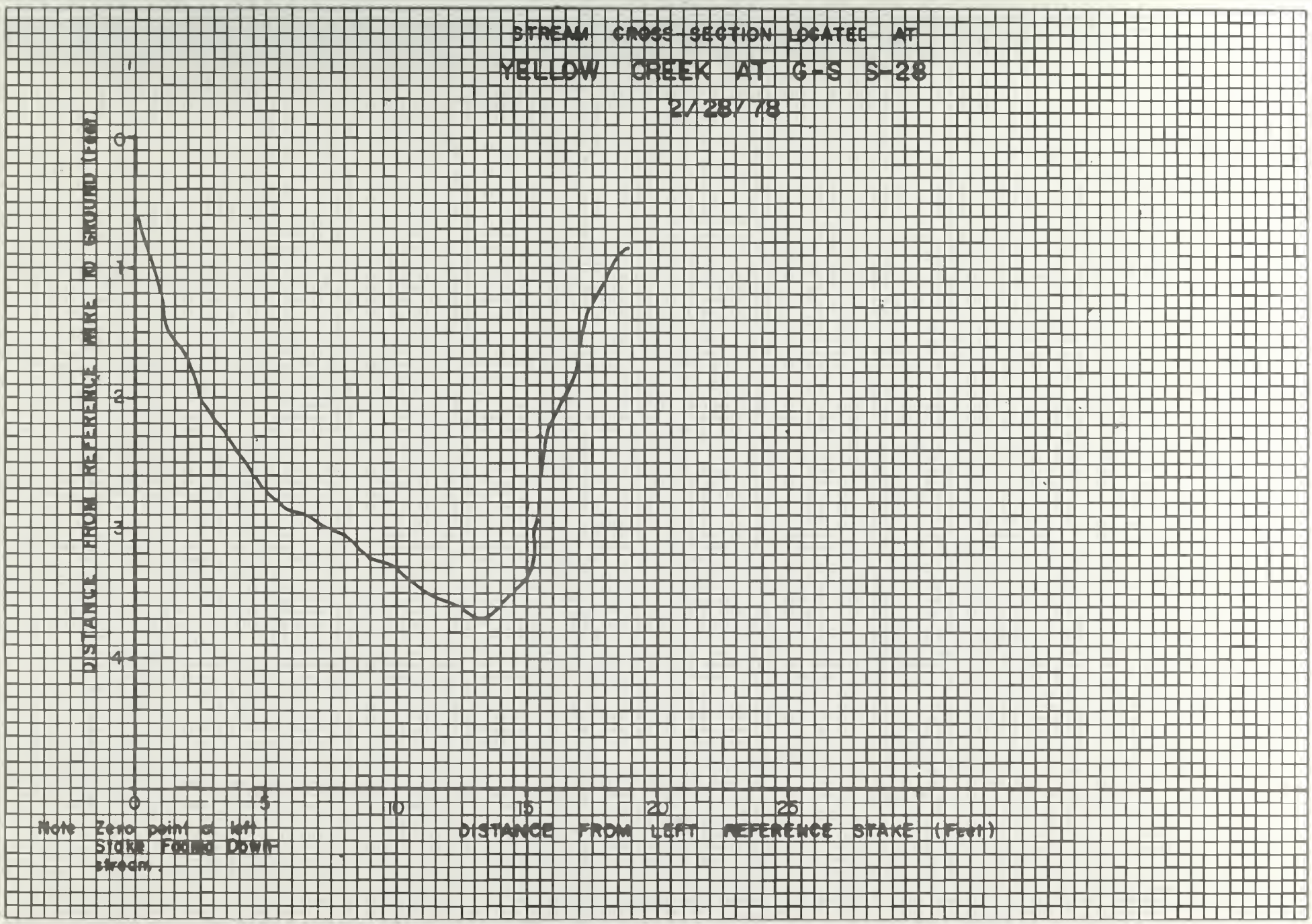


Figure 5-57a. Stream Channel Profile of Yellow Creek at GS S-28, 28 February.

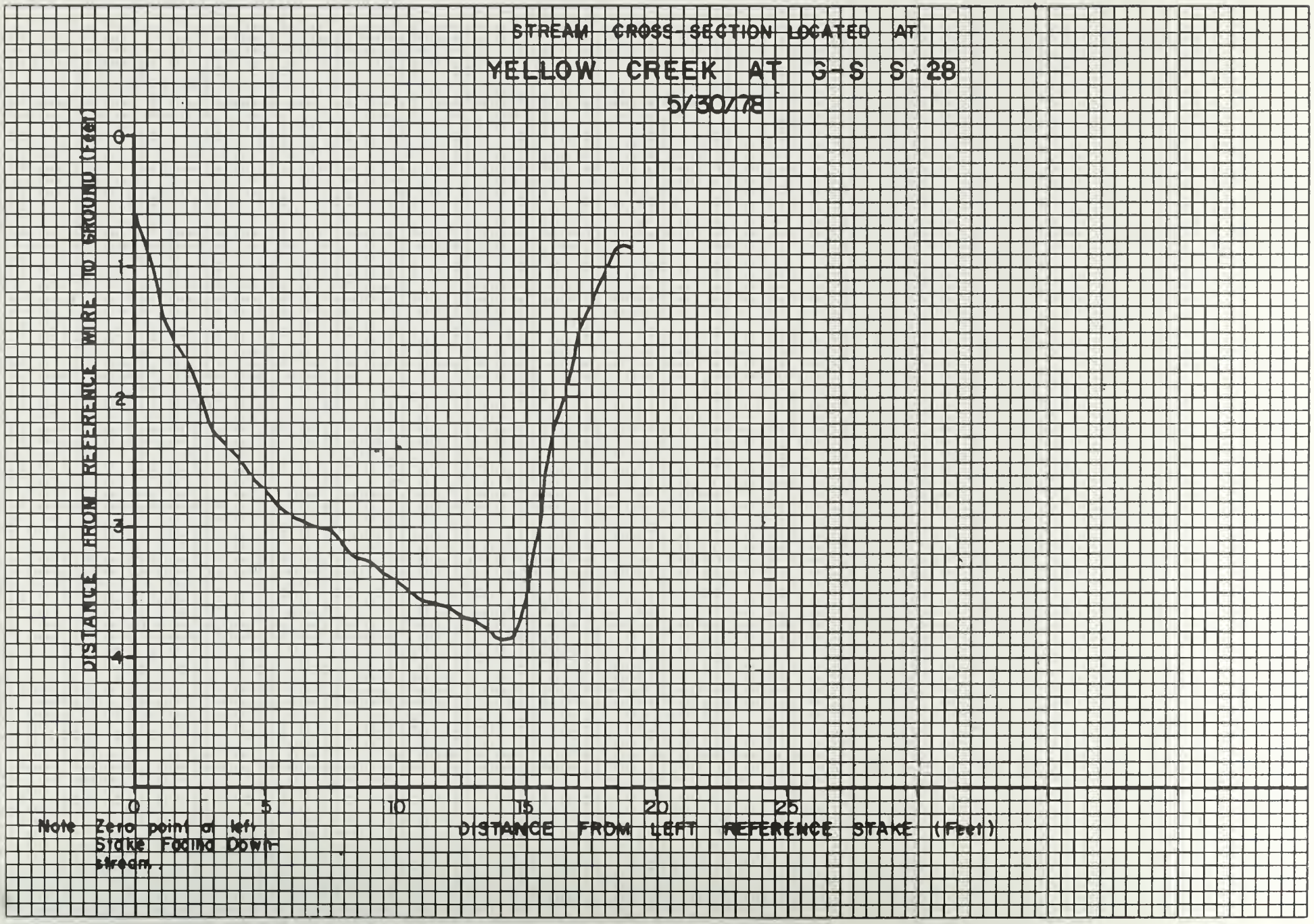


Figure 5-57b. Stream Channel Profile of Yellow Creek at GS S-28, 30 May.

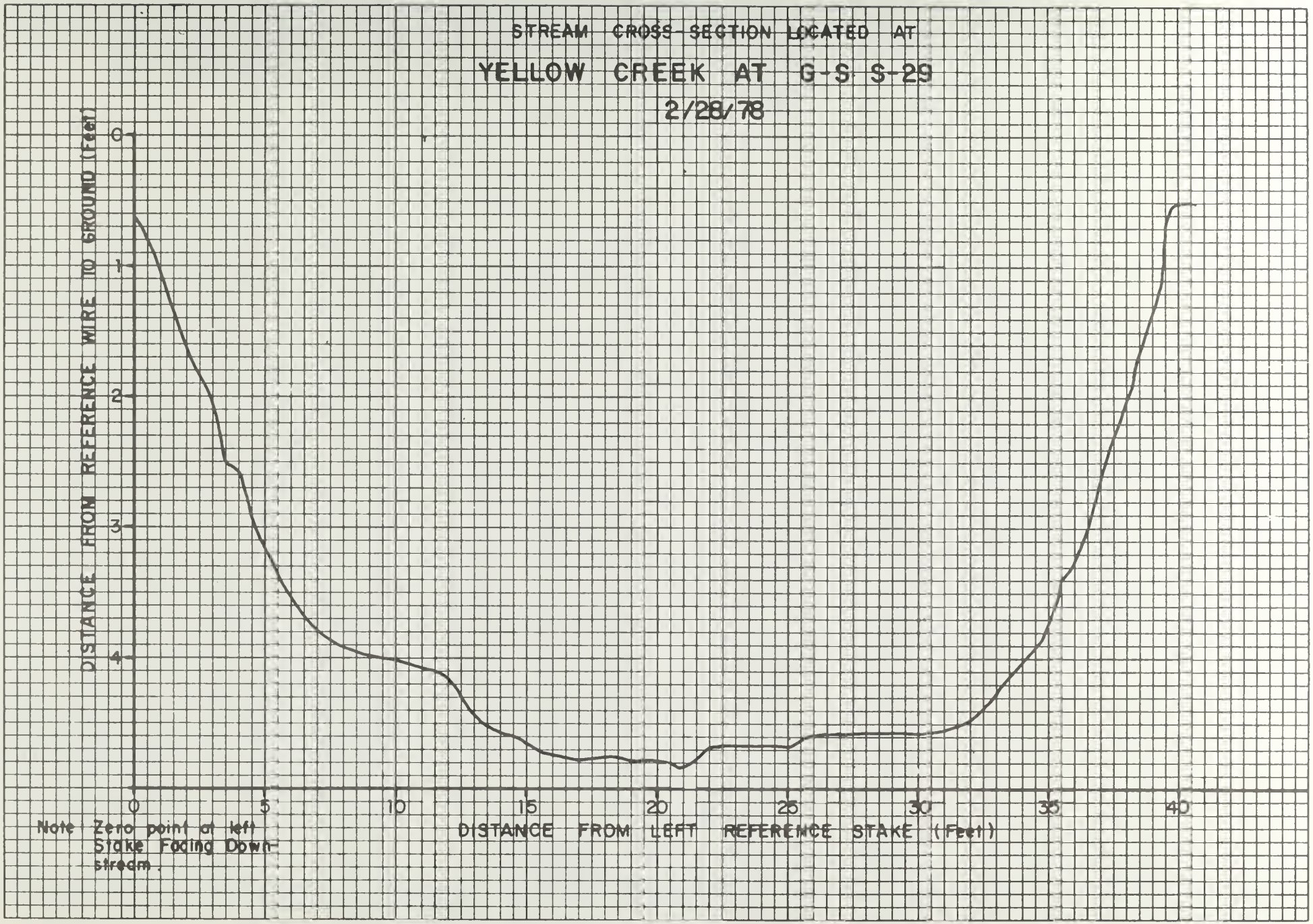


Figure 5-58a. Stream Channel Profile of Yellow Creek at GS S-29, 28 February.

Figure 5-58b. Stream Channel Profile of Yellow Creek at GS S-29, 30 May.

SECTION 6
SUMMARY

The MDP Environmental Monitoring Program was initiated in September 1977. The first year-end report, covering the period from September - November 1977, was submitted in February 1978. The current report represents the first mid-year data report; it covers the period of December 1977 - May 1978. Data presented in this report include air quality, meteorology, terrestrial ecology, aquatic ecology, and hydrology data.

During the six-month reporting period, development activities on the tract were accelerated. Data collection efforts were carried out throughout this period, and have served to identify the effects of the initial construction activities.

A variety of air quality parameters was measured during the period, including sulfur dioxide, hydrogen sulfide, nitrogen oxides, carbon monoxide, hydrocarbons, ozone, and particulates. Data for this period indicate that most air quality parameters have remained at the concentrations measured during the baseline studies. Sulfur dioxide, hydrogen sulfide, nitrogen oxides, and carbon monoxide were measured at or below the reliable threshold of the instruments for most of the period, and were well below secondary ambient air quality standards. Methane concentrations varied from 1.28 to 1.60 ppm during the reporting period. Total hydrocarbon concentrations ranged from 2.00 to 2.60 ppm. The source of the hydrocarbons on tract is unknown. Acting on direction of the Area Oil Shale Supervisor, hydrocarbon measurements have been dropped from the program.

Ozone concentrations for the six month period ranged from 0.032 to 0.088 ppm at Site 1 and from 0.005 to 0.072 at Site 3. The current primary ambient air quality standard for ozone (0.008 ppm) was violated at Site 1 29 times; there were no violations of the proposed primary ozone standard (.10 ppm). No violations of either current or proposed standards was observed at Site 3.

Particulate measurements were taken at four locations during the period. Several elevated concentrations of total suspended particulate matter were monitored at Site 6, which is adjacent to construction on the tract. The particulate concentration at that site is largely composed of fugitive dust.

Winds during the period were predominately from the west at Sites 1 and 2, and from the axis of the gulch at Site 3. Precipitation at Site 1 totalled 8.5 inches for the period. The Site 2 total was 8.0 inches.

Insolation and relative humidiy were also measured. Insolation values were high; relative humidity values low. These data compare closely with baseline values.

Results of the cooperative basin-wide visibility studies indicated excellant visibility for the area, ranging from a maximum range of 142 miles at view IV to a minimum range of 17 miles at View III.

Two series of noise level measurements were made. Series I, taken on tract at various distances from the construction activities indicated that sound level averages ranged from 45 to 66 dBA. Series II sound level averages, taken proximal to the shaft area ranged from 82 to 109 dBA.

Soils trace metal and conductivity studies were not scheduled for the reporting period. These studies are scheduled for August of 1981. Vegetation overflights are scheduled for July 1978.

Nine new range and nine new browse sampling sites were established during the period. Range sampling will be conducted this fall. Browse samples were taken in May 1978. Comparisons among spring browse data for 1976, 1977, and 1978 for mixed brush, pinyon-juniper, and upland sagebrush showed good agreement. Mixed brush habitat utilization data indicate that deer use is within "allowable use". The pinyon-juniper was shown to be in poor condition, however, these

utilization data do not differ drastically from baseline data. Sagebrush habitat showed a substantial difference from baseline, apparently due to increased use by feral horses, which was not related to development activities.

Mule deer pellet plot data for the period confirmed that portions of the area surrounding Tract C-a are important deer migration and/or wintering areas.

Seven bands of feral horses frequent the tract. Individuals number from 80 - 100.

No threatened or endangered animals or plants were observed during the study period.

Aquatic studies data were collected from six sampling sites during the period. Physical conditions observed during April 1978 and previous years were similar for Stations 13 and 14, except for water temperature and velocity, which appeared to have been affected by pump test discharges. The Yellow Creek stations differed from baseline levels for conductivity and dissolved oxygen. Physical conditions in the White River were similar to baseline values, but water temperature was lower. Water quality data from the White River were obtained and compared with previous data.

Periphyton data for the period were compared with data from previous seasons. Total algal cell densities were much lower at Station 13 in 1978 than in previous years. This is probably related to the higher flows and consequent scouring during pump test discharges. No other distinct trends were noted at other stations.

Macroinvertebrate data (benthos) for the 1978 season were compared with previous seasons. As with the periphyton, densities and diversities of organisms at Station 13 were greatly reduced. Other stations showed data comparable to baseline.

Hydrology studies were conducted during the period to identify conditions in the springs and seeps, streams, and in underground aquifers in relation to

construction activities. Water quality and quantity were measured at six surface water gaging stations, six springs and seeps, seven alluvial aquifer holes, and five deep groundwater aquifers. Additional monitoring, including measurements of erosion and sedimentation, was done in connection with dewatering pump tests.

Most water quality data from the stream gages fell within ranges reported during baseline. Parameters which reflected minor differences included pH, silica, sulfate, and specific conductance. Water quality was, in some cases, improved.

Data from springs and seeps showed close agreement with baseline data, with some improvements in specific conductance at 84 Ranch and Stake Springs.

Concentrations of most water quality parameters measured in the alluvial wells also fell within baseline limits. Water levels were generally lower in 1978 than in 1976. This may be attributed to lack of spring recharge in 1977.

Little change in water level was measured in the deep aquifers.

Pump test discharge data were taken during the period. A correspondence between daily discharge and flow and quality has not been demonstrated to date. This is receiving futher study.

Water levels have risen steadily in the alluvium since the onset of dewatering tests, and water quality has fluctuated a good deal.

Deep groundwater level data taken during pump testing showed a downward trend in most holes. Water levels in GS 11 (upper aquifer) and GS 15 rose slightly, however.

Stream erosion data indicate that the channel has been affected by increased flows from the dewatering tests.

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